JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 10 JUNE, 1917 No. 3

Proceedings of the Second Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The second annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at Stanford University, California, April 5 to 6, 1917. The business was transacted at the first and last meetings, but in the proceedings are all included in the first part.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman A. W. Morrill at 10.30 a. m., Thursday, April 5, 1917. There were 37 members and visitors present. Of this number the following were members:

Burke, H. E., Los Gatos, Cal.
Coleman, G. A., Berkeley, Cal.
Davidson, W. M., Sacramento, Cal.
Doane, R. W., Stanford University, Cal.
Essig, E. O., Berkeley, Cal.
Foster, S. W., San Francisco, Cal.
Herms, W. B., Berkeley, Cal.
Morrill, A. W., Phoenix, Ariz.
Morris, Earl, San Jose, Cal.
Van Dyke, E. C., Berkeley, Cal.

CHAIRMAN A. W. MORRILL: The meeting will please come to order. May we first have the report of the secretary-treasurer:

REPORT OF TREASURER

EXPENSES SINCE LAST MEETING

Feb. 5, 1917
Affiliation fee to Pacific Division, American Association for the Advancement of Science..... $5.00

April 2, 1917

Expenses for Stanford meeting:

Stamped envelopes, 1 c. legal size	$0.80
Multigraphing circular letter	1.25
Printing 150 copies application for membership	2.75
Total	$9.80

Examined and found correct.

R. W. DOANE,
H. E. BURKE,
Auditors.

CHAIRMAN A. W. MORRILL: There are a number of committees to be appointed as follows:

RESOLUTIONS COMMITTEE

H. J. Quayle G. P. Weldon
E. O. Essig

MEMBERSHIP COMMITTEE

H. S. Smith....1 year
H. J. Quayle....2 years
H. E. Burke....3 years

AUDITING COMMITTEE

H. E. Burke R. W. Doane

NOMINATING COMMITTEE

H. E. Burke R. W. Doane

The last part of the business meeting was called by Chairman A. W. Morrill, Friday, April 6, 4.30 p. m.

CHAIRMAN A. W. MORRILL: At the urgent request of A. L. Barrows, Secretary of the Pacific Division of the American Association for the Advancement of Science, for the appointment of a delegate to act on the affiliation committee, especially to consider means of assistance in the national crisis, which is to meet at 5 p. m., R. W. Doane has been appointed to serve for the ensuing year.

It was proposed by the secretary that other entomological societies of the Pacific Slope be invited to participate in the meetings of the Pacific Slope Branch in the future. Such meetings would be of mutual benefit and would have a tendency to stimulate work in all. This proposal was made in the form of a motion by H. E. Burke and seconded by R. W. Doane. Carried by the house.

CHAIRMAN A. W. MORRILL: We will now have the report of the nominating committee:

REPORT OF THE NOMINATING COMMITTEE

For chairman.....G. P. Weldon
For vice-chairman.....H. J. Quayle
For secretary-treasurer.....E. O. Essig

H. E. Burke,
R. W. Doane,
Nominating Committee.

REPORT OF THE MEMBERSHIP COMMITTEE

The membership committee approved of the following applications for membership with the recommendation that they be submitted to the regular membership committee of the association for final action:

Day, L. H., Hollister, Cal.
Ferris, G. F., Stanford University, Cal.
Freeborn, Stanley B., Berkeley, Cal.
Gray, Geo. P., Berkeley, Cal.
Henderson, W. W., Logan, Utah.
Penny, Donald D., Berkeley, Cal.
Severin, Henry H. P., Berkeley, Cal.
Vickery, R. K., Saratoga, Cal.
Wells, R. W., Bozeman, Mont.
Woodworth, H. E., Berkeley, Cal.
Herbert, F. B., Los Gatos, Cal.

By vote of the house the report of the nominating committee was accepted and the secretary instructed to cast the ballot for the election of the officers named.

The report of the membership committee was accepted with the instructions that the applications be referred to the general committee as proposed.

Upon motion of the house the meeting was adjourned.

E. O. Essig,
Secretary.

PART II. PAPERS AND DISCUSSIONS

It was impossible to report the discussions following the papers as no official reporter was secured for this purpose and rather than give a partial account, this part of the meetings has been omitted.

Chairman A. W. Morrill: The first paper on the program is one prepared by myself and is as follows:

COTTON PESTS IN THE ARID AND SEMI-ARID SOUTHWEST

By A. W. Morrill, *Phoenix, Arizona*

During the past few years there has been a notable increase in cotton production in the arid and semi-arid Southwest. This increase is of interest inasmuch as it has tended to offset the losses morf the Mexican boll weevil in the humid region of the cotton belt. It is of further interest since in Arizona and to a small extent also

in California, a kind of cotton, Egyptian, is being produced for which other sections of the country are not adapted and for which there will be an increasing demand as the Mexican boll weevil damage to the Sea Island cotton industry in the East increases.

The growth of the cotton industry in west Texas is shown by a comparison of a series of recent years with an earlier series. For the seasons of 1899, 1900, 1901 and 1902 the west Texas counties lying west of the ninety-eighth meridian, produced on the average 17 per cent of the total crop of the state whereas for the seasons 1911, 1912, 1913 and 1914 the same section produced on the average about 27 per cent of the state's crop.

In the extreme arid portion of the southwestern United States cotton has become firmly established as an important crop within the short space of seven years. In 1909 the total cotton production of the states of California, Arizona and New Mexico amounted to only 390 bales whereas in 1916 the production had reached a total of over 52,000 bales in these states. The New Mexico acreage is virtually an extension of the west Texas or semi-arid cotton-growing region and is of not as much interest as presenting new problems in economic entomology as are cotton-growing districts of Arizona and California. These are located in the most arid section of the United States where the annual rainfall averages less than eight inches. With its important relation to the dairy and beef feeding industries, cotton growing has become one of the corner-stones of agriculture in this part of the arid Southwest. Its direct returns to this region amounted to about six million dollars for the past season and it is expected that it will become a twenty million dollar industry within a few years.

The development of this new industry as briefly outlined has developed also the need for special protection against the introduction of pests and for a practical knowledge of other cotton pests which already exist in the arid Southwest. The existence in parts of southern Arizona of a native species of wild cotton plant (*Thurberia thespesiodes*) with its native insect enemies introduces an element of possible danger and a factor which is highly interesting from the scientific standpoint.

Cotton growing in the arid and semi-arid Southwest is confined to the Lower Sonoran area of the Lower Austral life zone and to the Tropical region on the lower Colorado. Passing westward from the ninety-eighth meridian in Texas, a marked difference in the pests of cotton is soon noted. Certain ones are found in abundance which do not occur or are rarely found in the humid region, others commonly found in both regions become more injurious to cotton and still others become less so. Further differences are noted between different localities just as local differences occur in the humid cotton belt.

In this paper no attempt is made to name all of the different species of insects which have been found on cotton or in cotton fields. There are dozens of insects, especially among the Hemiptera, which are commonly found on the cotton plant and which are recognized as capable of becoming injurious but which are not known to have done noticeable damage to cotton so far. In the future some of these species will increase injuriously from time to time, usually in restricted localities, while others which have already demonstrated their injuriousness will from time to time become temporarily of little or no consequence as cotton pests.

Hemiptera

Up to the present time the insect order Hemiptera has provided the largest number of the more destructive cotton pests found through the section under consideration and in Arizona and California, at least, these insects promise to become the most troublesome group judged from their combined capacity for damage to cotton.

In west Texas the conchuela (*Chlorochroa ligata*) (12 and 13) is the most prominent plant bug having a history as a cotton pest. This insect has been taken at various points in southern Arizona. It was found feeding on the bolls of Thurberia in the Santa Rita Mountains but so far as known has not been taken on cultivated cotton in Arizona or California. It occurs in the Salt River Valley, a single specimen having been taken near Mesa on alfalfa.

The brown cotton bug (*Euschistus servus*) of the humid cotton-growing states (13) is represented in Arizona cotton fields by one of the same genus (*E. impictiventris*) which up to this time has proven to be our most common pentatomid cotton pest. This has been of common occurrence on cotton in the Salt River Valley and in the lower Colorado Valley near Yuma but like its eastern relative its injuriousness is due to its general occurrence in small numbers in almost all cotton fields rather than to fluctuating abundance and occasionally severe outbreaks.

The Arizona cotton stainer (*Dysdercus albidiventris*) has been the cause of the most severe local insect injury to cotton so far observed in the Salt River Valley (17). It has also been found on cotton in the Gila Valley near Sacaton but has not been reported from the cotton-growing district of southwestern Arizona and southeastern California. Another Pyrrhocorid bug, *Euryopthalmus* (=*Largus*) *succinctus*, is common and widely distributed in the arid Southwest but there is only one record of its occurring on cotton in sufficient numbers to do noticeable injury. This observation (13) was made in western Texas. In the extreme arid Southwest it has been taken on cotton near Bard, California; Florence, Arizona; and Mesa, Arizona.

The western leaf-footed plant bug (*Leptoglossus zonatus*) which has been noted as an enemy of cotton in northern Mexico (13) is very abundant in parts of southern Arizona and has been taken on cotton in the Salt River Valley and at Bard, California. Its favorite food is the fruit of the pomegranate but it should be regarded as a cotton pest owing to its known capability for damaging the bolls and occasional injury to cotton may be expected from this species, as is done in the humid cotton sections by its eastern relatives (*L. phyllopus* and *L. oppositus*).

The tarnished plant bug (*Lygus pratensis* and its varieties)[1] was observed by Mr. W. D. Pierce of the Bureau of Entomology as injurious to cotton squares in the Imperial Valley in California in 1913 and the same species has since proven quite destructive locally (16) in the Salt River Valley in Arizona. Although this insect occurs throughout the eastern cotton belt it does not appear to have attracted attention as a cotton pest except in Arizona and California.

Orthoptera

Four or five species of Orthoptera have placed this insect order ahead of the Lepidoptera and of about equal grade with the Hemiptera in the total amount of damage to cotton in the arid Southwest. The most generally destructive species is the differential grasshopper (*Melanoplus differentialis*) well known also as a cotton pest in the humid sections (15). In the Salt River Valley ranking next to the differential grasshopper are two species of the genus Schistocerca (*S. vega* and *S. shoshone*) which are common in cotton fields and in one locality in 1913 proved exceedingly destructive (14). During 1916 a species of cricket was one of the most destructive cotton pests in the Imperial Valley, necessitating the replanting of several hundred acres, according to Mr. E. A. McGregor of the U. S. Bureau of Entomology, who, in connection with his cotton insect investigations, is giving special attention to this pest. Grasshoppers are also reported as among the leading Imperial Valley cotton pests.

Lepidoptera

The arid Southwest has an extremely formidable list of lepidopterous enemies of cotton, although the combined damage so far has not been very extensive. This list includes the cotton bollworm

[1]The late O. Heidemann identified several lots of this material as "*Lygus pratensis*," "*Lygus pratensis* var. *lineolarius*," "*Lygus pratensis* var." and "*Lygus* sp. near *pratensis*." Evidently *Lygus pratensis* is a variable species and it will require special study to properly distinguish the southwestern forms as subspecies or to prove that they are merely color varieties.

(*Heliothis obsoleta*), the cotton leafworm (*Alabama argillacea*), the salt marsh caterpillar (*Estigmene acræa*), the cotton boll cutworm (*Prodenia ornithogalli*), the fall webworm (*Hyphantria cunea*), the western army cutworm (*Chorizagrotis agrestis*) the cotton leaf perforator (*Bucculatrix thurberiella*) and an undetermined bollworm which attacks the bolls of the Arizona wild cotton.

In their consideration of the distribution and destructiveness of the cotton bollworm in relation to life zones, Quaintance and Brues (21) say: "In Texas, from about the ninety-eighth meridian westward, the bollworm rapidly becomes of less and less importance along with the diminishing rainfall." In Arizona and California cotton-growing districts the bollworm attacks corn as extensively as it does in the humid eastern cotton states but for some as yet unexplained reason the insect has thus far done very little damage to cotton in these sections. It is noteworthy, however, that in the arid Laguna district in Mexico, about 500 miles south of Phoenix at an elevation of 3,700 feet, the cotton bollworm has during certain seasons caused heavy losses.

The cotton leafworm was found on Thurberia plants in the mountain canyons of southeastern Arizona, and on cultivated cotton in the Salt River Valley and near Tucson in the summer of 1913. The next season it was found in Graham County in eastern Arizona where cotton was being tried out on a small scale about 75 miles from any other plantings. The insect has not been found near Yuma although carefully searched for and Mr. McGregor of the U. S. Bureau of Entomology informs me that he failed to find a single specimen of the leafworm in the Imperial Valley in 1916. In one instance the writer observed a Salt River Valley Egyptian cotton field partially defoliated by the leafworm but this was late in the season and apparently no material damage was done to the crop.

The salt marsh caterpillar is a common pest in Salt River Valley cotton fields but there is no record of its injury to cotton elsewhere in the arid Southwest. The injury from this insect is sporadic and the occasional local outbreaks which have been noted have apparently been due to the insects having completely consumed the supply of a preferred food plant, a common weed known as the yellow-flowered ground cherry (*Physalis angulata* var. *linkiana*).

The cotton boll cutworm and the fall webworm can only be recorded as among those cotton pests present in Salt River Valley fields. The actual damage noted in any case has been inappreciable.

Cutworms did considerable damage in the spring of 1916 in one locality in the Salt River Valley, necessitating the replanting of several acres where the use of poisoned bran was not resorted to in time. Attempts to breed out the insects were unsuccessful but it is be-

lieved that all specimens of the worms found were "western army cutworms."

The cotton leaf perforator is a cotton pest which is evidently native of the arid Southwest. It was originally found on the Arizona wild cotton but has since appeared on cultivated cotton in the Salt River Valley (15) and the Imperial Valley (11), strongly indicating that the insect has other native food plants than the Thurberia. If, however, the Arizona wild cotton is the insect's only native food plant and the Salt River Valley infestation is traceable to this source, the insect may have been carried to the Imperial Valley by means of cotton seed shipments. Owing to the activity of parasites this insect is not considered a very serious cotton pest although in 1914 it was very abundant in the Salt River Valley and in 1916 in the Imperial Valley.

The unidentified Thurberia or wild cotton bollworm is considered by the writer to be more widespread and destructive to its food plant than is the wild cotton weevil. The full grown larva is robust and about an inch in length and the adult is therefore a moth which we may presume to be fairly capable as a flier.[1] It is to be expected that this insect will be found in the cotton fields of the Casa Grande or Salt River Valley in Arizona within a few years. In captivity the worms feed as readily on Egyptian cotton bolls and squares as upon the Thurberia cotton and the importance of the insect as a pest will depend on its adaptability to conditions in irrigated cotton fields at elevations much lower than their present known limits.

COLEOPTERA

While the Mexican cotton boll weevil (*Anthonomus grandis*) has made some progress into the western section of Texas it has not thus far been able to fully adapt itself to semiarid conditions (8, 9, 10, 18). This does not in the writer's opinion preclude the possibility of this insect quickly adapting itself and proving injurious if introduced into the extreme arid sections where cotton is grown entirely under irrigation.

The Thurberia or Arizona wild cotton (*A. grandis thurberiæ*) weevil which is found only in and near certain mountain ranges in southeastern Arizona is properly regarded with apprehension. It is a form of the cotton boll weevil which is thoroughly adapted to arid conditions but at present it is harmless, and may remain so indefinitely. In the event that it appears at any time in the future in the cotton fields of the Casa Grande Valley—a new district where cotton will be grown

[1] Attempts to rear the adult have so far been unsuccessful. Dr. H. G. Dyar, who examined specimens of the larvæ, noted that they resembled those of *Sacadodes pyralis*, a worm which attacks cotton bolls in Trinidad.

this season, located about fifty miles from the insects' present range—the suspension of cotton growing in the district for one season would offer a practical means of complete eradication. The Arizona cotton fields have been closely inspected in the past in order that this and other cotton pests may be promptly detected in the event of their introduction. Proportionally more attention will be given to the new cotton district mentioned which lies between the Salt River Valley and the Santa Catalina Mountains. Even with its proximity to the cotton fields of Arizona, the wild cotton weevil is insignificant in comparison with the pink bollworm as a menace to the cotton industry of the arid Southwest. This latter pest will be mentioned again. The relation of elevation to the future distribution of the weevil in the arid Southwest is an interesting subject for conjectures but not a safe matter to investigate. The insect has been found at elevations from about 2,750 to 7,000 feet but is reported by Coad (3) as more abundant on plants growing at elevations from 3,500 to 5,000 feet. The cotton plantings in the Casa Grande Valley are all below 1,500 feet elevation and in the Salt River Valley below 1,300 feet. The discontinuance of cotton growing near Tucson, permanently it is hoped, has removed the most important element of danger, which consisted practically of an intermediate step between the present habitat of the weevil and the important cotton-growing districts of lower elevations.

Homoptera

The cotton aphis (*Aphis gossypii*) is the only representative of the Homoptera which has so far proven injurious to cotton in the arid Southwest. In the season of 1914 this insect, known in the older cotton states as a cotton pest only on account of occasional injury to very young plants, was notably destructive to cotton throughout the greater part of the growing season in the Yuma and Imperial Valleys (15). While no appreciable injury has so far been reported it is interesting to note that adults of a species of the insect family Aleurodidæ were observed on cotton in the Imperial Valley by Mr. W. D. Pierce in 1913 and a similar observation was made by Mr. Pierce and the writer in the Salt River Valley. The possibility of white flies becoming injurious to cotton occasionally is shown by a statement from Mr. E. A. McGregor of the U. S. Bureau of Entomology, located in the Imperial Valley in cotton insect investigations, who writes concerning them: "They frequently rise in clouds as one brushes through the rows." In the humid cotton belt we have a record by Ashmead of similar abundance of an Aleyrodid (*Asterochiton abutiloneus*) in Mississippi with but slight injury.

Thysanoptera

The only notable injury to cotton in the United States by insects of the order Thysanoptera is that by a western species, the bean thrips (*Heliothrips fasciatus*) in the Imperial Valley (7 and 20). This species occurs in the Salt River and Yuma Valleys and has been noted as injuring beans in the former section but so far has not been found on cotton in Arizona in injurious numbers. However, temporary injury to a few young cotton plants by another species (*Microthrips piercei*) was once noted in the Salt River Valley (14).

Acarina

Two species of mites occur in Arizona which are of interest in a consideration of cotton pests. The common two-spotted mite (*Tetranychus bimaculatus*) is a pest of violets and sometimes of strawberries in the Salt River Valley but there is no record of its occurrence on cotton anywhere in the arid Southwest. From the fact that hot dry weather is favorable for this pest in the East we must regard it as dangerous in its possibilities as a pest of cotton. The second representative of the Acarina referred to above is the wild cotton blister mite (*Eriophyes thurberiæ* Bks.) which is quite destructive to the Thurberia plant and would be an undesirable addition to our list of pests of cultivated cotton if it were to spread from its present habitat. This, so far as known, is limited to certain mountain canyons in southern Arizona.

In a general consideration of cotton pests a more or less arbitrary standard must be set in deciding what species are worthy of mention. As has been stated, it is not the writer's intention to include in this paper a complete list of insects which have been collected on cotton and which are capable of doing damage. Only those concerning which definite observations have been recorded are mentioned herein. In comparison with the humid cotton belt it is interesting to note that to date the arid Southwest has a list of 20 species of insects which can be definitely recognized as pests of cultivated cotton and in addition two species of insects and one mite which are pests of Thurberia or Arizona wild cotton, making a total of 23.

East of the ninety-eighth meridian there are at least 42 insect pests and one mite concerning which we have definite records of appreciable injury to cotton.

The order Lepidoptera leads in both sections, having 18 in the East and eight in the West. The order Hemiptera follows with 11 in the East and six in the West.[1] Four representatives of the order

[1]Including one which is common in the arid Southwest of this country and which is known as a cotton pest from observations in arid northern Mexico, which in a general way belongs to the same cotton zone.

Orthoptera are listed for each section. Of the Coleoptera there are six eastern cotton enemies and two western—counting *Anthonomus grandis* and *A. grandis thurberiæ* as two species. The order Hymenoptera contributes two species to the list of cotton enemies in the East and none in the West, Homoptera two in the East and one in the West, Thysanoptera none in the East and one in the West. Of the Acarina there is one species which has proven injurious to cotton in the East and one in the West—this latter one being confined at present to wild cotton.

Eight species are injurious to cotton in both the humid and arid sections while at least two of the eastern species, the false chinch bug (*Nysius angustatus*) and the two-spotted red spider (*Tetranychus bimaculatus*), are common in some and probably all of the cotton growing localities of the arid Southwest but have not yet proven injurious.

A survey of the insect enemies of cotton is of special interest at this time when the industry is confronted with the most serious menace which has ever appeared on the North American continent. The presence of the pink bollworm (*Gelechia gossypiella*) in the Laguna district of northern Mexico (23) calls for the most vigorous measures for its extermination for the protection of the cotton industry of the United States, whatever difficulties may be involved in a problem of this kind on foreign soil and even if the expense amounts to ten million dollars or to twice this amount. Even the entrance of our country into a great war in the interests of humanity should not blind us to the danger in the existence of this insect at our very doors. There is no single product of the soil which is of as great importance and so indispensable to mankind as cotton and with our past experience with the Mexican boll weevil and the extensive investigation of miscellaneous cotton pests made during the past few years it is now generally acknowledged, East and West, even in new cotton-growing districts, that the continued success of this great industry is more dependent on the exclusion, control and eradication of insect pests than on any other factor.

Literature

(1) Coad, B. R. Relation of the Arizona Wild Cotton Weevil to Cotton Planting in the Arid West. Bul. 233, U. S. D. A., pp. 1–12. May, 1915. A consideration of the subject named based on investigations conducted in 1914.

(2) Coad, B. R. Recent Studies of the Cotton Boll Weevil. Bul. 231, U. S. D. A., pp. 1–34. August, 1915. This includes a report of investigations of biology of *Anthonomus grandis thurberiæ* at Victoria, Texas, in 1913.

(3) Coad, B. R. Studies on the Biology of the Arizona Wild Cotton Boll Weevil. Bul. 344, U. S. D. A., pp. 1–23. January, 1916. A detailed report of life-history investigations of *Anthonomus grandis thurberiæ* made in 1914 near Tucson, Arizona.

(4) Coad, B. R. and Pierce, W. D. Studies of the Arizona Thurberia Weevil on Cotton in Texas. Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 23–27. March, 1914. Studies of biology of *Anthonomus grandis thurberiæ* at Victoria, Texas, in 1913.

(5) Cook, O. F. A Wild Host Plant of the Boll Weevil in Arizona. Science n. s., vol. 27, No. 946, pp. 259–261. February, 1913. This article contains the first record of the occurrence of a weevil attacking *Thurberia thespesioides* in Arizona.

(6) Cockerell, T. D. A. Some Insect Pests of the Salt River Valley and Remedies for Them. Bul. 32, Ariz. Agr. Exp. Sta., pp. 288–289. Brief mention made of injury of bollworm to corn in Arizona and New Mexico.

(7) Coit, J. E. and Packard, W. E. Imperial Valley Settlers Crop Manual. Bul. 210, Cal. Agr. Exp. Sta., pp. 184, 181 and 240. January, 1911. Injury by bollworm to corn and tomatoes in the Imperial Valley is mentioned in this bulletin but no mention made of injury to cotton. Injury by *Heliothrips fasciatus* to cotton leaves is reported.

(8) Hunter, W. D. The Status of the Cotton Boll Weevil in 1909. Circ. 122, Bur. Ent., U. S. D. A., pp. 1–8. December, 1910. Contains a discussion of effect of semi-arid and arid conditions on Mexican cotton boll weevil.

(9) Hunter, W. D. (Remarks.) Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 27–28. March, 1914. A brief discussion of cotton growing in semi-arid and arid sections with reference to *A. grandis* and *A. grandis thurberiæ*.

(10) Hunter, W. D. and Pierce, W. D. The Mexican Cotton Boll Weevil. Bul. 114, Bur. Ent., U. S. D. A., pp. 23–29. February, 1912. Refers to relation of arid and semi-arid conditions on *A. grandis*, an extension of the discussion by Hunter in Circular 122.

(11) McGregor, E. A. *Bucculatrix thurberiella*, A Pest of Cotton in the Imperial Valley. Jour. Econ. Ent., vol. 9, No. 5. October, 1916. Notes on injury by cotton leaf perforator in the Imperial Valley in 1916, also description of stages.

(12) Morrill, A. W. The Mexican Conchuela in Western Texas in 1905. Bul. 64, Part I, Bur. Ent., U. S. D. A., pp. 1–14. April, 1907. A report of observations on an outbreak of this insect (*Chlorochroa ligata*) in extreme west Texas, including reference to its injury to cotton.

(13) Morrill, A. W. Plant Bugs Injurious to Cotton Bolls. Bul. 86, Bur. Ent., U. S. D. A., pp. 24–25, 74, 94. June, 1910. This includes a report of investigations of the conchuela, the grain bug (*C. sayi*) and the bordered plant bug (*Euryopthalmus succinctus*), all three of which had been found injuring cotton only in the semi-arid and arid sections of Texas and in arid sections of Mexico. The occurrence of the leaf-footed plant bug (*Leptoglossus zonatus*) in cotton fields in Durango, Mexico, is also mentioned.

(14) Morrill, A. W. Cotton Pests, Fifth Annual Report, Ariz. Comm. Agr. & Hort., pp. 38–48. December, 1913. A discussion of the bollworm, cotton leafworm, and two grasshopper pests (*Schistocerca vega* and *S. shoshone*) of cotton and their remedies, also of *Anthonomus grandis thurberiæ*, the Thurberia or wild cotton bollworm and the Thurberia blister mite (*Eriophyes sp.*). The following cotton pests are mentioned: cotton boll cutworm (*Prodenia ornithogalli*); the Mexican Conchuela; the grain bug; leaf-footed plant bug (*Leptoglossus zonatus*); the bordered plant bug (*Euryopthalmus succinctus*); the cotton aphis (*Aphis gossipii*) and the cotton red spider (*Tetranychus bimaculatus*). Injury to cotton by *Microthrips piercei* on one occasion is noted.

(15) MORRILL, A. W. Cotton Pests, Sixth Annual Report, Ariz. Comm. Agr. & Hort., pp. 37–46. December, 1914. A discussion of the cotton aphis injury at Yuma in 1914 and relation of *Hippodamia convergens* to its control, of the salt marsh caterpillar, cotton leafworm, cotton bollworm, the differential grasshopper (*Melanoplus differentialis*) and the cotton leaf perforator.

(16) MORRILL, A. W. Cotton Pests, Seventh Annual Report, Ariz. Comm. Agr. & Hort., pp. 41, 43–45. December, 1915. Includes a discussion of a tarnished plant bug (determined as *Lygus* sp. near *pratensis*) with mention of the cotton leaf perforator, the red spider (*Tetranychus bimaculatus*) and the bollworm.

(17) MORRILL, A. W. Cotton Pests, Eighth Annual Report, Ariz. Comm. Agr. & Hort., pp. 45–49. December, 1916. Includes an extended discussion of cotton stainer injury to cotton bolls with special reference to the Arizona cotton stainer (*Dysdercus albidiventris*), also notes concerning the scarcity of the cotton leaf perforator in 1916 evidently as a result of control by parasites and of the occurrence on cotton in southern Arizona in 1916 of the bollworm, pentatomid bugs, cutworms and *Coryzus validus*.

(18) PIERCE, W. D. The Occurrence of a Cotton Boll Weevil in Arizona. Jour. Agr. Research, vol. I, No. 2, pp. 89–98. November, 1913. This includes notes on the occurrence of the Arizona wild cotton weevil in Arizona. This insect is described as *Anthonomus grandis thurberiæ* and distinguished by comparative studies from *A. grandis*.

(19) PIERCE, W. D. and MORRILL, A. W. Notes on the Entomology of the Arizona Wild Cotton. Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 14–23. March, 1914. This consists in a report on explorations and observations made by the authors in 1913. Notes are included on the wild cotton boll weevil, the cotton leafworm, the Thurberia bollworm, a blister mite, a Cecidomyid gall maker, a mealy-bug, the cotton leaf perforator or bucculatrix and a lepidopterous leaf folder (*Dichomeris deflecta*). A total of eighty-three different species of insects and mites are mentioned including twenty-five which may be classed as injurious.

(20) RUSSELL, H. M. The Bean Thrips. Bul. 118, Bur. Ent., U. S. D. A., p. 30. October, 1912. This bulletin contains four paragraphs quoted from notes by V. L. Wildermuth concerning injury by the bean thrips (*Heliothrips fasciatus*) to cotton in the Imperial Valley during 1910 and 1911.

(21) QUAINTANCE, A. L. and BRUES, C. T. The Cotton Bollworm. Bul. 50, Bur. Ent., U. S. D. A., pp. 28, 29. 1905. Contains on pages mentioned a brief statement concerning status of the bollworm in the Lower Sonoran area of the lower Austral life zone.

(22) TOWNSEND, C. H. T. The Cotton Square Weevil of Peru and its Bearing on the Boll Weevil Problem of North America. Jour. Econ. Ent., vol. 4, No. 2, pp. 244–248. April, 1911. The writer presents his views in regard to the future development of cotton growing in the arid Southwest with special reference to the supposed immunity of this section to the cotton boll weevil (*Anthonomus grandis*).

(23) ———. Pink Bollworm. Jour. Econ. Ent., vol. X, No. 1, p. 225. A note concerning presence of *Gelechia gossypiella* in northern Mexico.

CHAIRMAN A. W. MORRILL: The next paper on the program will be presented by Dr. H. H. P. Severin.

MEDITERRANEAN FRUIT-FLY (CERATITIS CAPITATA WIED.) BREEDS IN BANANAS

By HENRY H. P. SEVERIN, PH. D.

In an article entitled, "Banana as a Host Fruit of the Mediterranean Fruit-Fly," Back and Pemberton (1, p. 802) "seriously question the statement" made in one of my publications (6, p. 70) that the "fruit-fly was also bred from a half-ripe banana under field conditions." Four scientists have bred the Mediterranean fruit-fly from bananas. Back and Pemberton, however, endeavor to cast doubt upon the results obtained by three of these naturalists. The reader is entitled to the data which I shall quote from scientific journals and correspondence.

My seriously questioned statement, that the "fruit-fly was also bred from a half-ripe banana under field conditions," was published in an article (6) which was read in more expanded form before the American Association of Economic Entomologists. Since the editor of the JOURNAL OF ECONOMIC ENTOMOLOGY, in which this article was published, requested me to give a brief summary of the paper read, the sentence in question was condensed from several statements published in an earlier and more detailed paper (5).

I quote verbatim the statements which were published in my summarized paper (6): "In the last number of the JOURNAL OF ECONOMIC ENTOMOLOGY, V, No. 6, pages 443–451, we published a paper entitled, 'Will the Mediterranean Fruit-Fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions?' There is no question of doubt but that the Mediterranean fruit-fly will occasionally breed in ripe and over-ripe bananas under Hawaiian conditions. The fruit-fly was also bred from a half-ripe banana under field conditions." It is evident that I referred the reader in my summarized paper (6) to the earlier and more detailed paper (5).

I now quote the statements which were published in our earlier and more detailed paper (5, p. 448): "During the mosquito campaign, when the banana trees were cut down in Honolulu, hundreds of bunches of bananas were examined to see if there was any evidence that the pest was breeding in bananas under field conditions. Hundreds of bananas containing maggots were removed from these bunches and placed in jars containing sterilized sand. From these bananas a small number of Mediterranean fruit-flies, numerous specimens of an Anthomyid, *Acritochæta pulvinata* Grims.; two species of Ortalidæ, *Euxesta annonæ* Fabr. and *Notogramma stigma* Fabr., and a number of species of Drosophilidæ were bred. The fruit-flies were bred from but two bananas, one of which when taken from the bunch was

decayed at the flower scar and had a bruise extending through the peel. This banana when removed from the bunch was yellow in color beneath the decayed area and gradually shaded over to green towards the other end." It was this banana which I referred to as a half-ripe banana in the previous-quoted paragraph. It is evident that the Mediterranean fruit-fly was not bred from bananas growing under natural conditions, due to the fact that the fruit was removed from bunches on trees that had been cut down.

Back and Pemberton (1, p. 802) also write, "The fact that Severin reared numerous specimens of the decay flies, *Acritochæta pulvinata*, *Euxesta annonæ* Fab., and *Notogramma stigma* Fab., besides a number of species of Drosophilidæ, is ample evidence that the trees from which the two fruits were taken had been cut sufficiently long for decay to have started in many fruits, had he not stated that one of the two fruits from which he reared adult flies was in a bruised and decaying condition and that its pulp had already turned yellow beneath the decayed area." In their evidence submitted, however, the authors fail to take into consideration that we (5, p. 448) have published the fact that "the Anthomyid and two species of Ortalids mentioned above were also bred frequently from green Chinese bananas removed from bunches on growing trees in banana plantations. These bananas were decayed around the flower scar. . . ."

Kirk (3, p. 9), of New Zealand, was forced to burn consignments of fruits, including the banana, because they were infested with the maggot of the Mediterranean fruit-fly. Back and Pemberton (1, pp. 801–2) state that "from the arrangement of the text of Kirk's bulletin, the Mediterranean fruit-fly (*Ceratitis capitata*) is definitely listed as a banana pest. The bulletin is, however, a compilation taken for the most part verbatim from various articles on fruit-flies appearing in the Reports of the Agricultural Department of New Zealand, or from circulars issued by the department. A person unfamiliar with the Australian situation is at a loss to know to which of several fruit-fly pests reference is made in the reports of fruits found infested by maggots at the ports of entry. Thus, in the Thirteenth Volume of the Agricultural Reports, 1905, where the list including the banana among those fruits found infested was originally published, no reference is made to either the Queensland or the Mediterranean fruit-fly; it is merely stated that the fruits listed were burned because found infested with the 'dread maggot.' In the report for 1906 it is definitely stated that only the Queensland fruit-fly (*Dacus tryoni*) was reared that year from a list of fruits including the banana. The biologist of Western Australia in his report for the year 1898 stated that the Queensland fruit-fly had been brought to Western Australia in bananas."

In order to convince the most skeptical that the Mediterranean fruit-fly was bred from bananas by Kirk, of New Zealand, I shall publish the following sentences from a letter written March 5, 1913, by Kirk to me on this subject: "The Mediterranean fly which is mentioned in my reports as having been obtained from bananas and pineapples were bred from maggots obtained from imported fruit of those varieties. I cannot now state positively the variety of banana. . . ."

Back and Pemberton (1, p. 802) write, "French, of Victoria, Australia, states that adults of the pest were reared from bananas (*Musa* sp.) exported from Queensland, Australia, and that on many occasions he has proved eggs to have been deposited in green bananas before shipment from Queensland to Melbourne. Both Kirk and French are aware that the Queensland fruit-fly (*Dacus tryoni*) is a pest of bananas grown in Queensland and that confusion between the two fruit-flies might occur if observations were made by untrained inspectors."

The following quotation shows that French (2, p. 4) and his son conducted the breeding experiments of the Mediterranean fruit-fly from bananas on one occasion at least: "The following is an account of some experiments, dealing with the Mediterranean fly, which were carried out by the Assistant Entomologist (Mr. C. French, jun.) and myself during 1906."

"The larvæ of this fly were found in bananas imported from Queensland on the 14th August, and on being placed in the breeding jars pupated on the 20th August; the perfect insects emerged on the 4th October and lived for several weeks, water, with a little sugar added, being the food placed at their disposal."

In the Hawaiian Islands certain varieties of bananas are not immune from the attacks of the Mediterranean fruit-fly under natural conditions. Mr. J. C. Bridwell, formerly in connection with the Hawaiian Board of Agriculture, bred the Mediterranean fruit-fly from ripe bananas of the Popoulu variety and from a green Moa variety. The Moa variety, however, was mature and about to turn yellow and in addition, the peel was so cracked that the pulp was well exposed (1, pp. 795–6).

Bibliography

(1) Back, E. A. and Pemberton, C. E., 1916. Banana as a Host Fruit of the Mediterranean Fruit-fly. Jour. Agr. Research, V, No. 17, pp. 793–804.

(2) French, C., 1907. Fruit-flies. Dept. Agr. Intell. South Australia, Bul. No. 24, pp. 1–14.

(3) Kirk, T. W., 1909. Fruit-flies. New Zealand Dept. Agr. Div. Biol., Bul. 22, pp. 1–18.

(4) Severin, H. H. P., and Hartung, W. J., 1912. Will the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions? Mon. Bul. State Com. Hort. Cal. I, No. 9, pp. 566–9.

(5) SEVERIN, H. H. P. and HARTUNG, W. J., 1912. Will the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions? Jour. Econ. Ent. V, No. 6, pp. 443–451.

(6) SEVERIN, H. H. P., 1913. Precautions Taken and the Danger of Introducing the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) into the United States. Jour. Econ. Ent. VI, No. 1, pp. 68–73.

CHAIRMAN A. W. MORRILL: As we shall probably have plenty of time we might as well discuss the papers as we go along. Discussions are now in order.

Mr. Dudley Moulton, Prof. R. W. Doane, E. O. Essig and Dr. Severin took part in the discussion which followed.

CHAIRMAN A. W. MORRILL: The next paper will be read by Mr. G. F. Ferris.

METHODS FOR THE STUDY OF MEALY-BUGS

By G. F. FERRIS, *Stanford University, California*

The economic importance, both actual and potential, of certain of the mealy-bugs renders the problem of recognizing the various species one of more than merely academic interest. It is the problem of discriminating between foe and foe or foe and neutral and thus it is of direct interest and of directly perceptible importance to the economic entomologist especially in California where certain species of mealy-bugs are among the worst of pests.

However, it is no exaggeration to say that of the nearly 100 species of mealy-bugs and their allies thus far described from North America, including some 35 from California, not more than three or four are recognizable at all on the basis of the existing literature if taken apart from their typical host and their type locality. Furthermore these three or four are not at all times and under all circumstances recognizable with certainty, even upon the basis of the direct comparison of specimens, by means of the methods and the characters at present in use.

In support of this latter statement I may adduce as evidence the fact that I have at hand at the present time a slide mount of a Pseudococcus determined by one who is perhaps as familiar with the mealy-bugs of this state as anyone and labeled "*Pseudococcus citri.*" The slide contains four specimens and of these three are *Pseudococcus longispinus* and one is *Pseudococcus obscurus*, or as it is better known, *Pseudococcus bakeri*. This is a confusion of three of the most widely spread and most familiar species of the state. Nor is this by any

means an isolated instance of the confusion of these species. To emphasize further the degree of confusion that exists in this group it may be added that the material labeled "type" of one species described from this state contains specimens of three species belonging to as many different genera. Another species is based upon the male of a Ceroputo and the female of a Pseudococcus and there are at least two others which appear to be based upon two different species.

The existence of the present unsatisfactory conditions affords grounds for a justly severe criticism of the methods of systematic entomology as they have been applied in this particular group. However, this is a question which it would be out of place to pursue further. The present paper is concerned only with a consideration of the means by which the existing conditions may perhaps be changed for the better.

The present confusion may be ascribed to two factors, operating both separately and together.

Of these factors one is to be found in the continued use by coccidologists, as specific criteria, of the relative lengths of the segments of the antennæ, expressed in the so-called antennal formulæ. The weakness of these antennal formulæ as diagnostic characters has been implied or even openly admitted even by those who have most consistently clung to them and has been most conclusively demonstrated by Smith[1] who found that the formulæ of ten antennæ of each of five species of Pseudococcus "varied as much as the specifically diagnostic formulæ published for all the species of Pseudococcus." Yet it is upon such characters as these that most authors have based their new species and their discussions in regard to specific relationships. Other characters usually given as supplementary to the antennal formulæ are equally non-significant, as was also pointed out by Smith in the paper already referred to.

Attempts have been made to refine the usual method of presenting these antennal formulæ by embodying them in graphs, but the result is hardly satisfying for no clue is afforded by these graphs to the specific identity of the individuals upon which the graph is based. Inasmuch as two or even more species may occur together upon the same host this objection is serious. Furthermore, the construction of such graphs requires several individuals and does not aid in the identification of isolated specimens.

The effect of the use of these formulæ has been not only to render useless practically all the published descriptions but also, because of the painfully evident variability of the antennæ, to induce the belief that the mealy-bugs are inherently variable in all their structures,

[1] Smith, P. E. Specific Characters Used in the Genus Pseudococcus. Annals Entomological Society of America, vol. 4, pp. 309–327. (1911.)

and present no stable characters upon which determinations may be based. As a matter of fact such a conclusion is very far indeed from the actual facts.

The second factor, and that with which this paper is really concerned, lies in the lack of a satisfactory technique for the preparations of specimens for study. The usual method has been to clear the specimens in caustic potash and then to mount in balsam or to mount in balsam without clearing, the results in either case not being especially fortunate. In some cases the specimens become so clear that it is even difficult to find them on the slide and in no case can anything more than the antennæ and legs be seen without an inordinate amount of eyestraining. In nearly all cases the characters that are actually of the greatest value can not be seen at all. Because of all this, determinations made by the comparison of specimens with types are frequently no more to be relied upon than those made upon the basis of the literature.

The solution of the difficulty lies in the utilization of a means of staining the specimens in order to accentuate the characters that are of especial importance. This is a method that has not usually been popular, probably in part because the methods usually recommended are more or less time consuming and in part because it has not really been shown that these methods produce results of any especial value.

For the staining of coccid preparations in general and for the particular method here advocated the author claims no originality whatsoever. It is believed, however, that it has not before been asserted that for the satisfactory study of mealy-bugs and their allies the use of properly stained preparations is not only desirable but is in fact necessary. It is the non-use of such methods that has previously prevented at least one author from producing results that would have rendered the present paper entirely unnecessary.

The method used has been essentially that recommended by Stafford[1] for use with Diaspine scales, but with modifications chiefly directed toward a general reduction in the amount of time consumed. It is applicable to other insects than coccids for it has proven eminently satisfactory for use with certain aphids, particularly Chermes and Phylloxera, and with the larvæ of Cecidomyidæ. The stain used is Magenta Red and may be purchased in liquid form. It should be diluted to one-half or one-fourth its original strength with water when used.

In its essentials the method is extremely simple. The specimens to be prepared are boiled in caustic potash in the usual manner and then

[1]Stafford, E. W. Studies in Diaspinine Pygidia. Annals Entomological Society of America, vol. 8, pp. 67–73. (1915.)

removed to clean water in which the body contents are washed out with more than usual care. They may then be transferred directly to the stain, which for this purpose is most conveniently contained in deep-hollow slides having a ground glass surface upon which data may be written, covered with a cover glass and set away. Six hours in the stain is sufficient, this being in strong contrast to the 100 hours recommended by Stafford. The specimens are removed from the stain into 95 per cent alcohol in which the excess stain is washed out, are then placed for an instant in carbol-xylene and mounted in balsam.

The result is a preparation in which all chitinized portions, the antennæ, legs, setæ and chitinized areas, are stained a more or less deep red while the remainder of the derm is left practically unstained. It not only becomes easier to study the characters that can be seen in the usual mounts but other characters are brought out that are not ordinarily to be seen and that have not, as far as I am aware, previously been noted by any one.

Smith[1] has pointed out the possible value as specific criteria of the "cerrari" or groups of pores and differentiated spines that occur on the margin of the body and these structures are indeed of much importance. In fact it is probable that a much more satisfactory basis for generic groupings can be found in the number of pairs of these cerrari than in the characters at present used and they are also of value for the recognition of species.

In addition to these cerrari, however, there occur in some species, certain chitinized and deeply staining areas associated especially with the cerrari of the anal lobes and on the ventral side of these lobes. It is these areas of which I have previously spoken as characters not previously noted. They are remarkably constant in shape and extent and permit the instant and certain recognition of some species. In other species they are not present, in which case the cerrari alone must be relied upon. With the use of all these characters, the cerrari, the dorsal and ventral body setæ and the chitinized areas, the distinguishing of the various species of mealy-bugs becomes in general practically no more difficult than the distinguishing of the various species of diaspine scales. The differences are readily appreciable and are no more variable than those which must be used in almost any group. Given proper study upon the basis of adequate material and with the aid of the methods here advocated, or of equivalent methods, the present confusion in the "soft scales" should rapidly disappear.

---

[1] Smith, P. E. A Study of Some Specific Characters of the Genus Pseudococcus. Journal of Entomology and Zoölogy, vol. 5, pp. 69, 81, figs. (1913.)

The paper was followed by a discussion by several members as to more detail in the methods used.

CHAIRMAN A. W. MORRILL: The next paper will be presented by H. E. Burke.

NOTES ON SOME WESTERN BUPRESTIDÆ[1]

By H. E. BURKE,

Specialist in Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture

During the past fifteen years various members of the Branch of Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, have made a number of observations on the life-histories and food plants of numerous species of western flathead borers or Buprestidæ. Some of these species are injurious to native and introduced fruit and shade trees and some other species may soon become so. One wood-infesting species has become a household pest and is doing some damage to interior wood work in the mountain towns.

Most of the species discussed inhabit deciduous trees but a few that may become pests of coniferous shade trees are included. In all cases the host plants listed are those from which the larva or adult has been taken from the wood or bark and not just resting on the foliage or bark. The fact that adults are found on the foliage or bark of a plant time after time is a good observation and worthy of record. It is also a good indication that the borer lives in the plant. There are cases, however, where it is not true and, in the writer's opinion, no plant should be listed as a host plant of a boring insect unless the insect is found living in the plant.

Some of the observations made on the feeding and egg-laying habits of the adults have suggested new methods of control and also, when considered with the life-history studies, new taxonomic relations.

In all, forty-four species are listed. Forty-three of these are western and from the following states: South Dakota, Montana, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon and California. One southern species is included to complete the host plants of the genus Trachykele. There are no records from Wyoming and Nevada but many of the species listed undoubtedly occur in those states.

The names as given follow Henshaw's "List of the Coleoptera of America, North of Mexcio." Many of the genera are in a deplorable state but the names given are those commonly used. The doubtful species have been verified by Mr. W. S. Fisher of the Branch of Forest

[1] Published by permission of the Secretary of Agriculture.

Insect Investigations, Prof. E. C. Van Dyke of the University of California and Prof. H. C. Fall of Pasadena, California.

Dicerca prolongata Lec.—Specimens from South Dakota, Colorado, Montana, Utah, Oregon and California; mines wood of injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*) and black cottonwood (*P. trichocarpa*); flies from July to September; feeds on bark of host plant; may attack planted poplars.

Dicerca obscura Fab.—What appears to be this common eastern species has been taken at Chico, California, in the wood of the Oregon ash (*Fraxinus oregona*); mines wood of injured, dying and dead trees; the eastern host plants are white oak (*Quercus alba* Linn.) and persimmon (*Diospyros virginiana*); flies from April to September. May become injurious to planted oak, ash and persimmon.

Dicerca hornii Cr.—Montana, Idaho, Washington, Oregon and California; mines wood of injured, dying and dead trees and shrubs; white alder (*Alnus rhombifolia*), mountain alder (*A. tenuifolia*), mountain mahogany (*Cercocarpus parvifolius*), plum (*Prunus domestica*), sweet cherry (*P. avium*), sumach (*Rhus glabra occidentalis*), poison oak (*Toxicodendron diversiloba*), California buckeye (*Æsculus californica*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*), buck brush (*C. cuneatus*) and snow berry (*Symphoricarpos racemosus*); flies from March to August; attacks domestic plum and cherry and probably other fruit trees; causes severe injury to the alder.

Dicerca sp. close to divaricata Say—Montana and Colorado; mines wood of dying and dead trees; mountain birch (*Betula fontinalis*), mountain alder (*Alnus tenuifolia*), bitter cherry (*Prunus emarginata*) and choke cherry (*P. demissa*); flies from July to September; may attack planted birches and rosaceous fruit trees.

Trachykele blondeli Mars.—Washington, Oregon and California; mines wood of normal, injured, dying and dead trees; giant arborvitæ (*Thuja plicata*), monterey cypress (*Cupressus macrocarpa*), McNab cypress (*C. macnabiana*) and western juniper (*Juniperus occidentalis*); flies from April to August; attacks planted cypress and probably other planted cedarlike trees.

Trachykele opulenta Fall—California; mines wood of normal, injured, dying and dead trees; California bigtree (*Sequoia washingtoniana*) and incense cedar (*Libocedrus decurrens*); flies April to June; attacks planted incense cedar and probably bigtree and redwood.

Trachykele nimbosa Fall—Oregon and California; mines wood of normal, injured, dying and dead trees; alpine hemlock (*Tsuga mertensiana*), white fir (*Abies concolor*) and red fir (*A. magnifica*); flies during June and July; may attack planted fir.

Trachykele lecontei Gory—Virginia, North Carolina, South Carolina and Louisana; mines wood of injured, dying and dead trees; bald cypress (*Taxodium distichum*); flies from March to July; may attack planted bald cypress.

Pœcilonota cyanipes Say (*?*)—Colorado, New Mexico and Utah; mines wood of injured trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from August to September; may attack planted poplars.

Pœcilonota ferrea Melsh. (*?*)—California; mines bark and wood of injured trees; aspen (*Populus tremuloides*) and nuttall willow (*Salix nuttallii*); flies from July to September; may attack planted willows and poplars.

Pœcilonota thureura Say (*?*)—Montana and Oregon; mines bark of normal trees; black cottonwood (*Populus trichocarpa*); flies in July and August; lays its eggs in crevices in the bark; may attack planted cottonwoods but according to Mr. Josef Brunner prefers the older thick-barked trees.

The classification of this genus is in a deplorable state and all of these species may be wrongly identified.

Buprestis confluens Say—Colorado, Utah and California; mines wood of injured, dying and dead trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from July to September; attacks planted cottonwood.

Melanophila drummondi Kirby—Practically all of the Rocky Mountain and Pacific states; mines inner bark and outer wood of normal, injured, dying and dead trees; western larch (*Larix occidentalis*), Engelmann spruce (*Picea engelmanni*), sitka spruce (*P. sitchensis*), western hemlock (*Tsuga heterophylla*), alpine hemlock (*T. mortensiana*), douglas spruce (*Pseudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), lowland fir (*A. grandis*), white fir (*A. concolor*), lovely fir (*A. amabilis*), noble fir (*A. nobilis*) and red fir (*A. magnifica*); flies from May to September; attacks and kills many trees, also causes defects to form in the wood of others; may attack coniferous shade trees.

Heretofore, has been mixed with the following species. *Melanophila sp.*—California; mines inner bark and wood of normal, injured, dying and dead trees; yellow pine (*Pinus ponderosa*), jeffrey pine (*P. jeffreyi*) and digger pine (*P. sabiniana*); flies from June to August; kills many second growth trees and assists Dendroctonus species to kill others.

Melanophila gentilis Lec.—Practically all of the Rocky Mountain and Pacific states; mines inner bark and wood of normal, injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*) and jeffrey pine (*P. jeffreyi*);

flies from March to August: attacks and kills small and large trees; very injurious to second growth in some localities; is the principal enemy of the sugar pine outside of *Dendroctonus monticolæ* Hopk.

Melanophila intrusa Horn—Colorado and California; mines inner bark of injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*) and rock pine (*P. scopulorum*); flies in June and July; usually lives in the suppressed limbs and tops but sometimes infests saplings; the larva indicates that it is quite different from the other Melanophila.

Anthaxia æneogaster Lap.—Practically all of the Rocky Mountain and Pacific states; mines bark and outer wood of normal, injured, dying and dead trees and shrubs; sugar pine (*Pinus lambertiana*), pinon pine (*P. edulis*), yellow pine (*P. ponderosa*), jeffrey pine (*P. jeffreyi*), digger pine (*P. sabiana*), knobcone pine (*P. attenuata*), Monterey pine (*P. radiata*), douglas spruce (*Pseudotsuga taxifolia*), weeping willow (*Salix babylonica*), garry oak (*Quercus garryana*), mountain mahogany (*Cercocarpus parvifolius*), service berry (*Amelanchier alnifolia*) and redbud (*Cercis occidentalis*); flies from March to September; commonly lives in the branches but often attacks and kills saplings and shrubs; very injurious to the redbud in some localities. It appears to the writer that there must be several species mixed.

Chrysobothris femorata Fab.—Montana, Colorado, Idaho, Arizona, and California; mines inner bark and wood of normal, injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*), black cottonwood (*P. trichocarpa*), lombardy poplar (*P. nigra italica*), gambel oak (*Quercus gambeli*), live oak (*Q. chrysolepis*), black oak (*Q. californica*), wild plum (*Prunus americana*), prune (*P. domestica*) and imported maple (*Acer dasycarpum*); flies from March to September; sometimes causes severe injury to poplar and maple shade trees as well as fruit trees. Many of the published records of this species in the west refer to *Chrysobothris mali*.

Chrysobothris mali Horn—Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; arroyo willow (*Salix lasiolepis*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), christmas berry (*Heteromeles arbutifolia*), plum (*Prunus domestica*), wild plum (*P. subcordata*), peach (*P. persica*), Oregon maple (*Acer macrophyllum*) and box elder (*A. negundo*); flies from May to August; lays its eggs singly in crevices in the bark; causes severe injury to shade and fruit trees; all of the Chrysobothris reared from the apple in California by the writer are of this species. These rearings were from Siskiyou, El Dorado and Los Angeles counties.

Chrysobothris nixa Horn—California; mines inner bark and wood of normal, injured, dying and dead trees; incense cedar (*Libocedrus decur-*

rens) and monterey cypress (*Cupressus macrocarpa*); flies from March to August; kills saplings and small trees. Very common in felled incense cedar. Reared once from the monterey cypress by Mr. F. B. Herbert.

Thrincopyge ambiens Lec.—Arizona; mines flower stems of the sotol (*Dasylirion wheeleri*); flies July and August; may infest yuccas and closely related plants.

Polycesta californica Lec.—Oregon and California; mines wood of injured, dying and dead trees and shrubs; cottonwood (*Populus fremonti*), white alder (*Alnus rhombifolia*), garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*), black oak (*Q. californica*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), pear (*P. communis*); christmas berry (*Heteromeles arbutifolia*), almond (*Prunus amygdalus*), redbud (*Cercis occidentalis*), Oregon maple (*Acer macrophyllum*) and manzanita (*Arctostaphylos viscida*); no specimens collected flying; emerges from host plant early in summer; causes some injury to fruit and shade trees.

Polycesta elata Lec.—Arizona; mines wood of injured, dying and dead trees; Arizona white oak (*Quercus arizonica*), emory oak (*Q. emoryi*), white leaf oak (*Q. hypoleuca*), hackberry (*Celtis reticulata*) and Arizona sycamore (*Plantanus wrightii*); no specimens collected flying; causes some injury to shade trees.

Polycesta velasco L. & G.—Arizona; mines wood of injured, dying and dead trees; catsclaw (*Acacia greggii*), mosquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*); no specimens collected flying; causes some injury to shade trees; may attack introduced acacias.

Acmæodera amabilis Horn—Arizona; mines wood of dead trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmæodera plagiaticauda Horn—California; mines wood of injured shrubs; manzanita (*Arctostaphylos viscida*); may injure planted shrubs.

Acmæodera angelica Fall—California; mines wood of injured and dying trees and shrubs; douglas oak (*Quercus douglasii*), poison oak (*Toxicodendron diversiloba*), deer brush (*Ceanothus integerrimus*) and buck brush (*C. cuneatus*); may injure planted oaks and shrubs.

Acmæodera hepburnii Lec.—California; mines wood of injured and dying trees; garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*) and pear (*Pyrus communis*); flies in May and June; injures fruit and shade trees by mining the wood and weakening the trunk.

Acmæodera acuta Lec.—California; mines wood of injured and dying trees; douglas oak (*Quercus douglasii*); may injure planted trees.

Acmæodera conneza Lec.—California; mines wood of injured trees; interior live oak (*Quercus wislizeni*); flies from May to July; injures shade trees.

Acmæodera van dykei Fall—California; mines wood of injured roots; interior live oak (*Quercus wislizeni*); flies from May to July; may attack shade trees.

Acmæodera cuneata Fall—Arizona; mines wood of injured and dying trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmæodera sp. near prorsa Fall.—California; mines wood of scars on living trees; interior live oak (*Quercus wislizeni*) and black oak (*Q. californica*); may injure shade trees.

Acmæodera mariposa Horn—Oregon and California; mines wood of injured and dying shrubs; mountain mahogany (*Cercocarpus parvifolius*), christmas berry (*Heteromeles arbutifolia*), poison oak (*Toxicodendron diversiloba*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*) and redbud (*Cercis occidentalis*); flies from April to June; feeds on the foliage of the hostplant; may attack planted shrubs.

Acmæodera sp. near pulchella Herbst.—Colorado and Utah; mines wood of injured and dying trees; gambel oak (*Quercus gambelii*); flies in July; may attack shade trees.

Chrysophana placida Lec.—Colorado, Utah, Washington, Oregon and California; mines cones and wood of normal, injured, dying and dead trees; mountain white pine (*Pinus monticola*), sugar pine (*P. lambertiana*), single leaf pinon (*P. monophylla*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*), jeffrey pine (*P. jeffreyi*), lodgepole pine (*P. murrayana*), digger pine (*P. sabiniana*), knobcone pine (*P. attenuata*), alpine hemlock (*Tsuga mertensiana*), douglas spruce (*Pesudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), white fir (*A. concolor*), red fir (*A. magnifica*) and giant arborvitæ (*Thuja plicata*); flies from March to September; is destructive to seed crop of knobcone pine; damages pine window and door casings in buildings and may attack wood of planted coniferous trees.

Agrilus angelicus Horn—California; mines twigs and small branches of normal trees; live oak (*Quercus agrifolia*); flies from May to July; feeds on the foliage of the host plant; lays its eggs singly on the outer bark of the twigs; girdles and kills twigs and small branches; damages shade trees by causing a ragged or scraggy appearance; takes two years for the life cycle. The published records on this distinct species are under *Agrilus politus* Say.

Agrilus sp.—California; mines bark and wood of branches and main trunks of normal shrubs and trees; madrone (*Arbutus menziesii*) and manzanita (*Arctostaphylos manzanita* and *A. viscida*); flies from May to August; feeds on the foliage of the host plant; lays its eggs singly on the smooth bark of the branches and trunk; girdles and kills branches and causes the formation of enlarged galls; takes two years for the life

cycle; may damage ornamental shrubs and shade trees. Some taxonomists consider this the same as the preceding species but the life-history and habits indicates that it is distinct.

Agrilus niviventris Horn—California; mines inner bark and wood of normal and dying trees; lombardy poplar (*Populus nigra italica*); flies from May to August; feeds on the foliage of the willow (*Salix lasiandra* and *S. lasiolepis*) and the host plant; lays its eggs singly in crevices in the bark; girdles and kills shade trees, sometimes causing severe damage.

Agrilus granulatus Say—Colorado and Montana; mines inner bark and wood of normal, dying and dead trees; willow (*Salix* sp.), black cottonwood (*Populus trichocarpa*) and common cottonwood (*P. deltoides*); girdles and kills limbs and trunk. Injurious to shade trees in Colorado.

Agrilus anxius Gory—South Dakota, Montana, Colorado, Idaho and Utah; mines inner bark and wood of normal, dying and dead trees; aspen (*Populus tremuloides*), common cottonwood (*P. deltoides*) and mountain birch (*Betula fontinalis*); flies from May to August; girdles and kills branches and trunk; causes severe damage to shade trees.

Agrilus acutipennis Mann.—Colorado; mines inner bark and wood of normal, injured and dying trees; gambel oak (*Quercus gambelii*); flies from June to August; feeds on the foliage of the host plant; lays its eggs in the crevices of the bark; girdles and kills branches and trunk; very destructive to native groves of oak in Colorado according to Mr. George Hofer.

Agrilus politus Say—Montana, Colorado, Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; mountain willow (*Salix monticola*), nuttall willow (*S. nuttallii*), arroyo willow (*S. lasiolepis*), weeping willow (*S. babylonica*), mountain alder (*Alnus tenuifolia*) and dwarf maple (*Acer glabrum*); flies from May to August; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and main trunk; life cycle appears to vary; Mr. Josef Brunner considers it to be two years in Montana but it seems to be only one in some parts of California; very destructive to alder in some parts of Montana and to willow in California; attacks weeping willow shade trees. There may be several species still mixed under this name. In practically all of our rearings greenish specimens occasionally appear. These have been identified by Mr. W. S. Fisher as *Agrilus solitarius* G. & H. The next species which is dark blue has also been considered a variety of politus but the life history and habits indicate that it is distinct.

Agrilus sp.—Oregon and California; mines inner bark and wood of

normal, injured and dying trees; white alder (*Alnus rhombifolia*) and mountain alder (*A. tenuifolia*); flies from April to July; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and trunk; life cycle seems to be one year; very destructive to the white alder in some parts of California; when an attack does not kill the tree it causes rough scars on the trunk and swollen galls on the branches; appears to be the only species that attacks the alder in California.

From an economic standpoint the two main points brought out by the preceding observations are: first, that the adults of some of the most injurious species feed on the foliage of the host plant where they may be fought with poison sprays; second, that they lay their eggs upon the bark where they may be reached by contact sprays.

Up to the present time the general methods of control recommended for flathead borers have been the cutting out and burning of the infested parts or the protection of the plant by repellent washes or protective coverings. These methods when carefully applied are very effective and will continue to be important but along with them the measures suggested in the preceding paragraph have their place and in many cases their prompt use ought to make the severer measures unnecessary.

Take, for instance, *Agrilus politus* which causes severe damage to the alder and willow often killing many trees in a group. The adults feed on the leaves and then lay their eggs on the smooth bark of the limbs and main trunk. An arsenic spray on the foliage should kill the adults and any of the oil or sulphur sprays should destroy the eggs on the bark. And the result should be the same in the case of *Chrysobothris mali* which is a destructive enemy of shade and fruit trees.

The main point in the use of any of these measures is careful observation to determine the amount of damage the insect is doing, the exact time when the control work should be done, that the proper method is selected to suit the particular conditions found and that the method used is properly applied. The most perfect remedy will not bring the best results unless it is used in the right place at the right time.

CHAIRMAN A. W. MORRILL: As it is now lunch time we had better adjourn until 2 p. m. as announced on the program.

Adjourned

After a very fine luncheon provided by the members of Stanford University for all members of visiting societies the meeting was called to order at 2 p. m. by Chairman A. W. Morrill.

CHAIRMAN A. W. MORRILL: The first paper for this afternoon will be read by Dr. H. H. P. Severin.

FRUIT-FLIES OF ECONOMIC IMPORTANCE IN CALIFORNIA

By Henry H. P. Severin, *Berkeley, Cal.*

(Withdrawn for publication elsewhere)

The paper was discussed by H. E. Burke, A. W. Morrill, R. W. Doane and others.

Chairman A. W. Morrill: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

NICOTINE SULPHATE AS A POISON FOR INSECTS

A. L. Lovett, *Entomologist, Oregon Agricultural Experiment Station*

A suggestion of nicotine sulphate as a stomach poison for insects was first brought to the writer's attention after reading the report of Mr. F. E. DeSellem, inspector at large, of North Yakima, Washington, on Black Leaf 40 as a spray for the codling moth.

Since the completion of the work included in this paper, has appeared the excellent article on "Nicotine as an Insecticide" by Mr. McIndoo, in the *Journal of Agricultural Research*, and still more recently the 1916 Horticultural Report of Yakima County, Washington, with the two seasons' rather startling results of Mr. DeSellem on the control of the codling moth. The results included in this paper supplement both in a measure and are offered as additional data on a very interesting topic. Nicotine sulphate as a contact insecticide is considered a very efficient, but expensive spray. The possibility of its broader insecticidal properties in commercial spraying as indicated in these papers may alter our present conception as to value versus service.

Series 1. For Foliage Eating Caterpillars

The caterpillars used in the tests were our common tent caterpillars (*Malacosoma pluvialis* Stretch). They were collected, tent and all, in the field feeding on the foliage of the wild rose. With the exception of Experiment A the foliage was allowed to dry for hours after applying the spray before introducing the caterpillars.

Experiment A.

April 9, 1916. 9.00 a. m.

Sprayed foliage of wild rose with "Pratt's Nicotine 40" 1–400, thoroughly saturating the foliage with a fine misty spray. Placed approximately 600 newly hatched larvæ of the tent caterpillar (*M.*

pluvialis) on the wet foliage. The caterpillars exhibited a most decided aversion to the sprayed foliage, crawling about, collecting in masses and suspending themselves on elongated web ropes and dropping off. By noon, fully 60 per cent were apparently dead, though none had fed. These died in a balled up heap in the center of the mass of foliage. The few remaining caterpillars were restless, sick and writhing about. Observations at 5.00 p. m. showed about all dead; some which had dropped apparently dead, showed signs of life, but were very sick. The next morning, April 10, all were dead or had left. A fair per cent of those which dropped had recovered and crawled away. One small incision in the margin of a leaf was observed, but there were no other apparent signs of feeding.

EXPERIMENT B.

April 13, 1916. 8.45 p. m.

Sprayed foliage of apple as follows:

No. 1, Pratt's Nicotine 40 1–800

No. 2, Black Leaf 40 1–1200

Applied as fine misty spray thoroughly saturating foliage. Placed on table to dry. April 14, 9.00 a. m., placed approximately 300 small caterpillars on each No. 1 and No. 2. Foliage perfectly dry.

The caterpillars showed a decided aversion, were restless, crawled about, formed long web ropes and dropped off. Often one would be observed to rear the head and half of the body from the foliage, writhe about and spew up drops of dark liquid as grasshoppers do, apparently very sick. At 3.00 p. m., 50 per cent were apparently dead, the others very sick. Many which had dropped and lay curled in grotesque positions as though having died in great pain, eventually recovered (after 3 hours or more) and crawled away. The following day, April 15, a few were observed to have fed on both Nos. 1 and 2. Where they had fed, they were apparently in all cases really dead. One fact stood out particularly, of the many which had dropped, apparently dead, without having fed, they had almost without exception, recovered and crawled away. The drop on No. 2 was a little heavier than on No. 1, with a little more feeding indicated on No. 1. The caterpillars were about all dead or had crawled away the next day, April 16, from both Nos. 1 and 2. To see if the action of the material was still effective, 75 fresh caterpillars were placed on No. 2. The action of the caterpillars was the same as that of earlier forms, restless, sick and dropping off. This would indicate that the action, whatever it is, extends over a period of three days at least.

EXPERIMENT C.

May 5, 1916.

Sprayed apple foliage with following:

No. 3, Black Leaf 40, 1–800

No. 4, Black Leaf 40, 1–1200

Thoroughly covered foliage with fine misty spray and allowed to dry for six hours. Placed approximately 1,000 half-mature tent caterpillars on each.

The results were practically identical with those of Experiments A and B with the immature forms. The material was apparently very repulsive, though no odor of nicotine could be detected. The foliage was placed where a breeze could blow across it. The caterpillars continued to act restless, dropped, writhed and spewed. The effect of the spray on these larger forms was slower. Also, more caterpillars were used in the tests. Daily observations were made up until May 19, a total of 14 days, when approximately all had left the sprayed foliage. Each day a number would drop, lie for approximately three hours as though dead, then recover and crawl away. Those which crawled away collected in a mass on the sill of the window. On May 10 and 11 these forms were collected and placed on fresh unsprayed foliage. Here they fed with great gusto and apparently showed no ill effects of the recent illness. On May 11, two caterpillars were found dead on No. 3; the foliage showed small feeding punctures. There were three dead on No. 4, which also showed slight evidence of feeding. The foliage was changed on May 12, first allowing it to dry thoroughly after applying the spray. On May 19, seven caterpillars were dead under No. 3 and 12 under No. 4. Feeding for the entire period amounted to a total of about two fair-sized leaves.

EXPERIMENT D.

May 19.

Dipped camel's hair brushes in Nicotine Sulphate 40 per cent and treated nearly mature caterpillars as follows:

No. 1. Black Leaf 40, 1–800, painted ventral surfaces of 10 caterpillars with moist brush and then placed caterpillars on fresh unsprayed apple foliage.

No. 2. Pratt's Nicotine 40, 1–800, allowed brush to dry for 24 hours, painted ventral surface of 10 caterpillars and placed on fresh unsprayed apple foliage.

No. 3. Black Leaf 40, 1–1200, allowed to dry 24 hours and treated as above.

No. 4. Pratt's Nicotine 40, 1–1200 treated as No. 1.

No. 1 and No. 4 nauseated, spewed up and dropped off; eventually recovered.

No. 2 and No. 3 restless for a time but eventually commenced feeding and were apparently normal. Not sick.

Conclusions

Nicotine sulphate is a very powerful repellent for caterpillars. They will not ordinarily feed from choice on foliage sprayed with it. Where feeding does take place, the action of the nicotine is apparently rapid and sure, even small bits of foliage sprayed with comparatively weak solutions, where devoured, killing after a short time. To what property of the spray one may attribute the general sick condition of the caterpillars is discussed in Mr. McIndoo's paper, page 98. Paralysis of the nerves by the volatile nicotine passing in through the tracheæ as he suggests is the most feasible explanation. The volatilization of nicotine sulphate must be very slow as this material is, theoretically, non-volatile. The possibility of the active agent being absorbed by the feet or through the skin and thus carried to the nerve centers is also suggested.

Series B, For Codling Moth

The tests of nicotine sulphate for the control of the codling moth were very unsatisfactsry and can hardly be considered good experimental data. The immediate cause for failure was an unavoidable late change in plans. The factors which make the test of little value are as follows: The orchard tract available for the test consisted of a run-down orchard of mixed varieties with their necessary individual variations. No comparison was made against the standard lead arsenate application. The nicotine sulphate was used in combination with lime-sulphur instead of soap. The season was a very backward one and the generations of the codling moth were very much delayed. A summary of the test is included in this paper that one may judge the results for whatever value they may have.

Four applications were made: 1, The calyx spray, May 10; 2, When eggs of first generation were deposited, June 16; 3, When first adults of second generation appeared, August 2; and 4, When majority of second generation moths were depositing eggs, September 8.

The following materials were used at each application:

1. Niagara dust sulphur 85 per cent plus Corona lead arsenate 15 per cent, as a dust.
2. Black Leaf 40, 1–400 plus lime sulphur 32° B., 1–35.
3. Pratt's Nicotine 40, 1–800 plus lime sulphur 32°, 1–35.
4. Black Leaf 40, 1–1200 plus lime sulphur 32°, 1–35.

While none of the materials gave satisfactory control, the comparative results are interesting. In the check, there were 29.65 per cent of wormy apples. Nicotine sulphate 1–1200 and 1–800 show but slight control, having respectively 26.8 and 26 per cent of wormy apples.

CODLING MOTH EXPERIMENT WITH NICOTINE SULPHATE

(*Cydia pomonella*)

(Total count 20,396 apples)

Treatment	Total Number of Apples	Sound		Unsound	
		Number	Percentage	Number	Percentage
Untreated Plat I, Baldwins	2,705	2,090	77.26	615	22.74
Untreated Plat II, Yellow Newtons	1,417	899	63.44	518	36.56
Mean			70.35		29.65
Dust (85 per cent sulphur)	513	451		62	
and 15 per cent arsenate	3,186	2,919		267	
Yellow Newtons	3,482	3,166		316	
Mean			91.39		8.61
Black leaf (1–1200), Plat No. II, Northern Spies	725 951	545 763	78.04	180 188	21.95
Black leaf (1–1200), Plat No. II, Yellow Newtons	509	348	68.36	161	31.64
Mean			73.20		26.80
Black leaf (1–400), Plat No. III, Baldwin	4,729	4,005	84.69	724	
Mean					15.31
Pratt's Nicotine 40 (1–800), Plat No. I, Yellow Newtons	711	466	65.54	245	34.45
Pratt's Nicotine 40 (1–800), Plat No. II, Baldwins	1,496	1,235	82.44	263	17.56
Mean			74.00		26.00

Nicotine sulphate 1–400 gave approximately one-half control or 15.31 per cent worms. The dust application gave by far the best control, showing only 8.6 per cent worms. The foliage of the dusted trees showed to an advantage. This material also checked the scab to a very fair degree, though the work was started too late to afford satisfactory control here.

1916. McINDOO, N. E. Effects of Nicotine as an Insecticide. Jour. Agri. Research, VII, pp. 89–121. 1916.

1916. DESELLEM, F. E. Nicotine Sulphate for the Control of the Codling Moth. Yakima County Hort. Rept. 1916, pp. 62–72.

CHAIRMAN A. W. MORRILL: The next paper by Prof. C. P. Gillette and L. C. Bragg will be read by the secretary.

THE MIGRATORY HABITS OF MYZUS RIBIS (LINN.)

By C. P. Gillette and L. C. Bragg

This is one of the best known aphides in both Europe and the United States, occurring upon the leaves of the various species of *Ribes*, especially the common red currant, but also known to attack the leaves of the European black currant, the Rocky Mountain wild currant, *R. aureum*, and occasionally the gooseberry.

Linnæus gave a very good description of this louse including the red leaf galls which it produces, so we are reasonably certain of the species he worked with. It has long been known that it leaves the currant bushes during the middle of the summer, but no one has definitely determined the alternate hosts.

Kaltenbach and Koch may have had this species under observation when studying *galeopsidis* on Stachys, which we have demonstrated is a common summer host of this species in Colorado.

Buckton, vol. II, pl. 39, fig. d, has evidently confounded the red leaf galls of this species with the work of *Rhopalosiphum ribis*, a fact referred to by Schouteden in his "Catalog of the Aphididæ of Belgique," p. 236.

Koch put this species in the genus *Rhopalosiphum*, probably because there is a slight enlargement of the cornicles toward the distal ends where the diameter is greatest.

Dobrovliansky, in *Review of Applied Entomology*, 1914, p. 81, is quoted as saying that this aphid is injurious to the black currant, but says nothing of the possibility of its having a different summer host.

Dr. Patch, in Bulletin 225 of the Maine Experiment Station, p. 55, 1914, mentions this as a common louse upon the currant in Maine and considers it a migrating species, but says that the alternate host plant is unknown.

Prof. H. F. Wilson, in his paper, "Biennial Crop Pests and Horticultural Report of the Oregon Agricultural College and Experiment Station," p. 94, 1912, speaks of this as a migrating species and gives a characterization of its different stages, including the egg, upon the currant, but does not suggest the summer hosts. He also mentions the gooseberry as an occasional host plant.

Van der Goot, in his paper on Blattlaus-Arten, Overgedrukt uit het Tigdschrift voor Entomologie, Deel LV, 1912, p. 72, considers *M. ribis* a migrating species and says it is possible that his *M. lamii* might be the migratory form of *ribis*.

Van der Goot, also, in "Beitrage zur Kenntnis des Hollandischen Blattlause," p. 113, 1915, reports the fall migrants of *M. galeopsidis* coming to the currant and the oviparous females laying eggs upon the

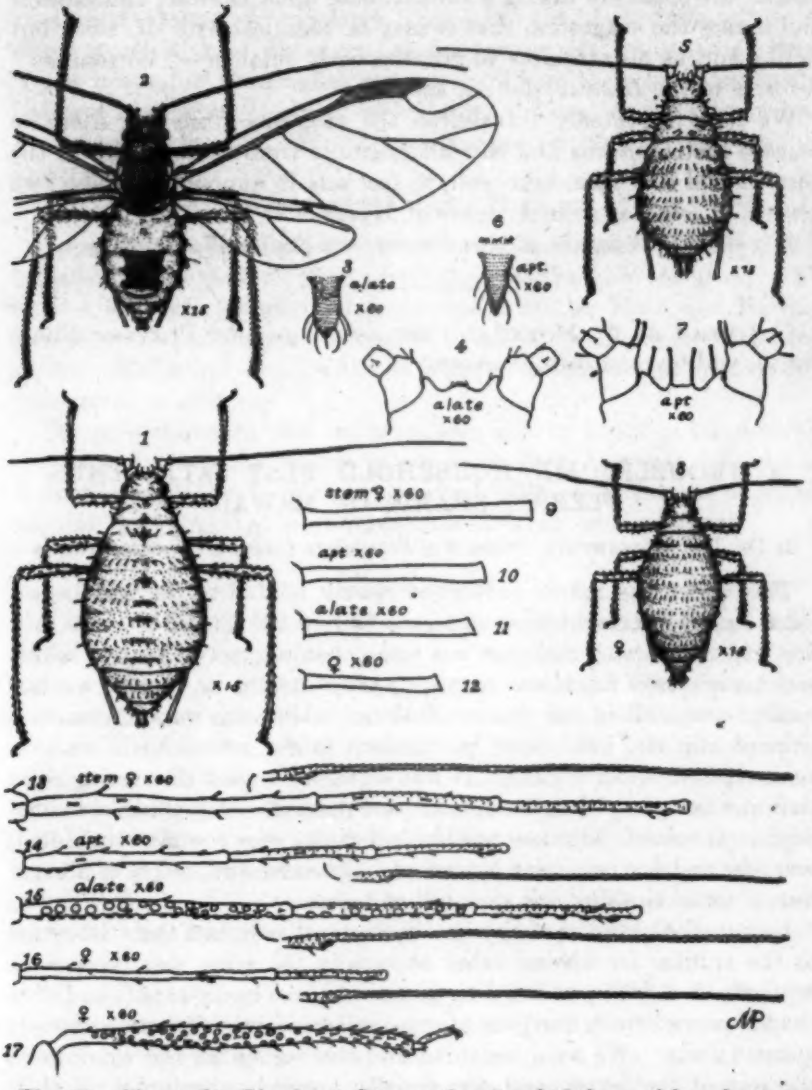

Fig. 17. *Myzus ribis* (Linn.). 1, Stem mother, 9 and 13 the cornicle and antenna of same; 2, alate viviparous female, and 3, 4, 11 and 15, the cauda, vertex, cornicle and antenna of the same; 5, apterous viviparous mother of the males, and 6, 7, 10 and 14, the cauda and gonopophyses, vertex, cornicle and antenna of same; 8, the oviparous female, and 12, 16 and 17 the cornicle, antenna and tibia of same.

Original, Miriam A. Palmer, Illustrator.

The apterous virgogene and the antenna of the alate male differ so little from figures 5 and 15 in the plate, it does not seem necessary to figure them.

twigs. He speaks of taking a similar louse upon *Lamium* and *Stachys* and makes the suggestion that it may be identical with *M. ribis*, but thinks not, as his attempts to transfer early summer—"Vorsommer"—forms to the *Lamium* did not succeed.

We have repeatedly transferred the migrants from the *Ribes* to *Stachys* and *Leonurus* and the fall migrants from these plants to the currant and had them take well, so feel safe in announcing these two genera, at least, as summer hosts of *Myzus ribis* Linn.

For structural details of this species, see Figure 17.

CHAIRMAN A. W. MORRILL: The next paper, by Professor Illingworth, will be read by the secretary.

A TROUBLESOME HOUSEHOLD PEST (ATTAGENUS PLEBIUS SHARP) OF HAWAII

By DR. J. F. ILLINGWORTH, *Professor of Entomology, College of Hawaii, Honolulu*

This insect has habits somewhat closely related to the well-known black carpet beetle (*Attagenus piceus* Ol.) of the United States. My first experience with this pest was upon opening up two trunks, which had been stored for about a year. After arrival in Hawaii we had packed away all of our winter clothing, which was superfluous in a tropical climate, but which we thought might be useful if we ever again visited colder regions. It was certainly a most distressing sight that met our gaze, when the trunks were opened—everything of animal origin was ruined. Our new woolen undersuits were completely riddled; fur, hair and feathers were a mass of fragments; and, worst of all, our heavy, outer clothing was shot full of holes.

I soon discovered that the beetles had not confined their attention to the trunks, for several other objects in the same storeroom were injured. A saddle, padded with sheep-skin, was badly eaten; and even the felt paper, which lined one of my small grips, was almost completely gnawed away. We soon began to find the beetles on the windows in the rest of the house, and occasionally noticed a beginning of their work in the closets. Fortunately, however, they do not give any trouble to clothing or other objects which are used frequently.

During subsequent investigations, I have found that this beetle is often destructive to dried fish in the Honolulu markets, though the principal injury to this product is by the larger dermestid, commonly known in the United States, as the leather beetle (*Dermestes vulpinus* Fab.). Dealers in brushes in Hawaii have also come to know this

pest, for it is frequently closely associated with the buffalo carpet beetle (*Anthrenus scrophulariæ* Linn.) in the destruction of their finest goods. I, also, discovered an interesting relation of these insects to the nesting of the English sparrows. Where these birds are in the habit of nesting on banks or in buildings the beetles are attracted to the masses of feathers and other animal matter used in the nest construction.

Distribution and History

Apparently these beetles have not been found outside the Hawaiian Islands, though they are pretty well distributed within the group. We have a number of records of specimens taken on Maui and Hawaii, and they are certainly abundant on Oahu,—probably a little investigation will disclose them on all the islands, for they are an insect easily transferred in shipping.

The earliest record that we have been able to locate is the description of this beetle by Sharp[1] in which he gives the note "Found in Houses in Honolulu." We are surprised, after observing the depredations of this pest, that more references to it can not be located.

Life-History

A study of the life-history was comparatively easy, since the several stages advanced so rapidly under our tropical conditions. In one instance the whole life cycle required only 150 days. It is interesting to compare this record with that of the closely related *Attagenus piceus* of the United States, which Chittenden found took two years for its development from egg to beetle.

Newly-emerged beetles were confined in a glass dish and supplied with some of the woolen cloth, which had been injured by the larvæ. A number of dead roaches and flies were also placed in the dish to insure sufficient food. After twelve days, mating was observed, but it was thirty-six days before the first eggs and newly hatched larvæ were discovered.

Egg.—The creamy-white of the eggs made it difficult to discover them on the cloth which was the same color, but after they were once observed it was rather easy to locate them with a lens. It was found that newly-laid eggs required an incubation period of about three days. In form the eggs are broadly oval; being about 1 mm. wide by 2 mm. long; the shape varying considerably, since they are rather soft.

Larva.—The newly hatched larvæ are noticeably large, compared with the eggs from which they emerge: see Figure 18, 1 and 2, which are drawn to the same scale.

[1] Trans. Royal Dublin Soc., vol. III, ser. II, 1885, p. 147.

The larvæ were supplied with the same kind of food as noted above for the adults. They showed a great fondness for dried insects, but in no case were they observed to eat their own cast skins, even when no other food was supplied them. Pupæ, however, were sometimes eaten if left in the same dish with the larvæ.

As is common with all Dermestids, there is great variation in the larval period. While the majority run through rather close together, there are always a few, which for some unaccountable reason, are exceedingly slow, even when all observable conditions are the same. Typical development may be stated as follows: First instar, 10 to 12 days; second instar, 16 to 18 days; third instar, 14 to 16 days; fourth instar, 15 to 35 days; fifth instar, 12 to 15 days; sixth instar, 17 to 25 days; seventh instar, 33 to 46 days. It is interesting to compare with this a specimen, almost full grown when taken from the trunk a year ago. It has hardly increased in size, though abundantly supplied with food; and has molted five times, at the following intervals; 47–37–74–68–87 days. Another individual, after feeding for two years upon dried insects, and molting fifteen times, showed no growth.

Pupa.—Pupation takes place wherever the larvæ are feeding,—the last larvæ skin being shed. The pupal stage lasts from 12 to 14 days.

Adult.—The beetles, apparently feed upon the same substances as the larvæ, for our specimens reproduced abundantly and lived for a period of 40 to 52 days. As is characteristic of Dermestids, they are able to live, generation after generation, without a sign of moisture, upon absolutely dry food material, and apparently do well even when sealed up away from the air.

TECHNICAL DESCRIPTION

The Larva.—No description of this stage has been published. Figure 3 shows the general appearance of a full-grown larva. The ground color is very dark brown, and the vestiture slightly lighter. The dorsal surface is covered with short, appressed hairs, and very sparsely interspersed with coarser erect hair arranged in a transverse row along the caudal border of each segment. The lateral tufts of the thorax are slightly denser than on abdomen, where the few hairs are somewhat longer; the caudal segment terminates in a pencil of long, delicate hairs of somewhat lighter shade. Compact, suberect hairs of head, and the legs rufus. The ventral surface is whitish, the abdominal region covered with blackish, appressed hairs, denser on the terminal segments. Length of full grown larvæ about 10 mm.

The Pupa.—No description has been given of this stage either, though the pupa, which is creamy white, and covered with a fulvous pubescens, resembles rather closely that of *Attagenus piceus*. The same peculiar openings are located along the medium dorsal region of the abdomen. (See Figure 18, 3 and 4.) Each of these openings is bordered by two chitinous plates, the cephalic one bearing minute teeth. The function of these openings is hard to determine, though it has been observed that the margins will quickly close upon and grip any object inserted into them. Pupa somewhat longer than adult, measuring 6 mm.

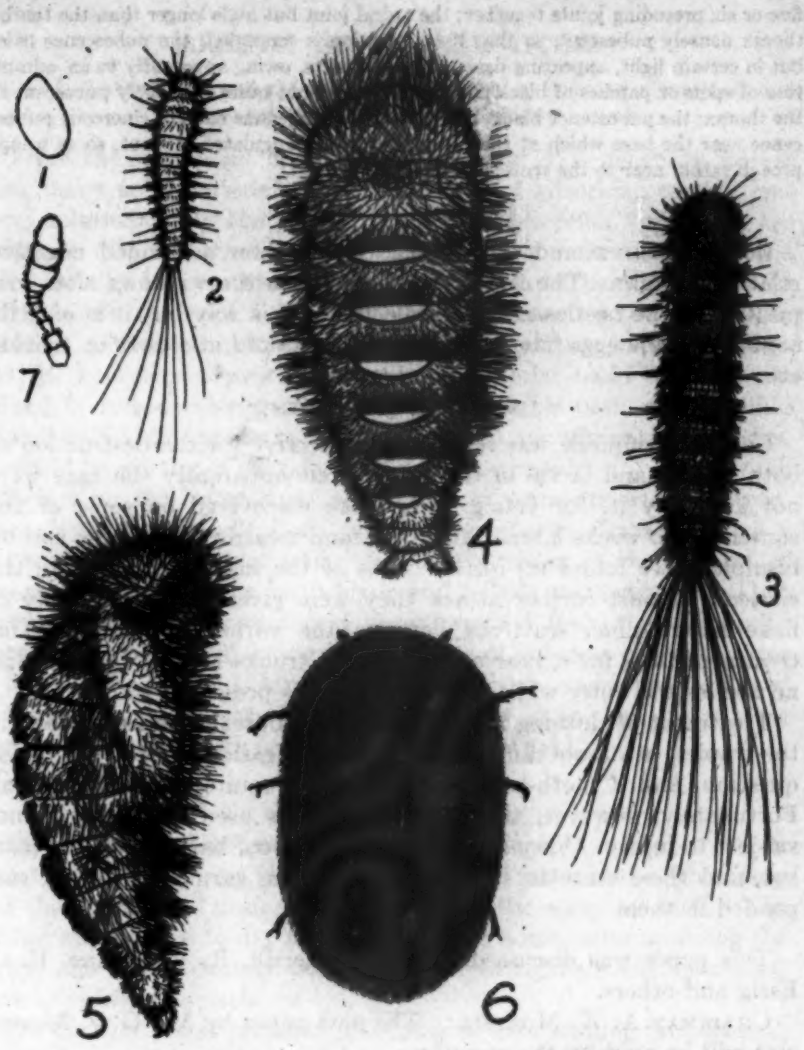

Fig. 18. *Attagenus plebius*. 1. Egg, x14. 2. Newly hatched larva x14. 3. Full grown larva, x10. 4. Dorsal view of the Pupa, x10. 5. Lateral view of Pupa, x10. Dorsal view of beetle, x10. 7. Antenna.

THE BEETLE.—It may be well to quote here from the original description since that publication is not easily accessible.

"Sat elongatus, opacus, dense pubescens, niger, antennis pedibusque rufis, capite, thorace, elytrorumque fascia angusta, angulata, subbasali pubescentiæ pallidæ. Long. 4–4½ mm. ♀ ♀"

"Similar in size, form and appearance to the European *A. verbasci*, but with only one pale band on the elytra. The specimens described are probably of the female sex, and have the antennæ short, the club three-jointed, and in length equal to the

five or six preceding joints together; the apical joint but little longer than the tenth; thorax densely pubescent, so that its punctation is concealed; the pubescence pale, but in certain light, appearing dark on middle parts, owing apparently to an admixture of spots or patches of black pubescence; elytra not quite so densely pubescent as the thorax; the pubescence black, but there is a conspicuous band of cinereous pubescence near the base which at the suture is strongly angulated in front, so as to approach rather near to the scutellum; legs entirely red."

Relation to Light

Both the larvæ and the mating beetles show a decided negative relation to light. The latter, however, fly to the windows after ovipositing. The beetles may be collected in this way but it is of little avail, since the eggs have already been deposited in closets or trunks, etc.

Control Measures

Carbon bisulphide was found to be effective for the destruction of both beetles and larvæ in the trunks, but apparently the eggs were not killed by it, for young larvæ were discovered on some of the contents two weeks later. After a second treatment with the carbon bisulphide we found no further signs of the insects. To insure the contents against further attack they were given a liberal supply of flake naphthaline, scattered between the various garments. This treatment lasts for a year or more if the trunks are not opened, and no beetles will enter while the naphthaline is present.

Treatment of clothing in closets of open houses, such as we have in the tropics, is a more difficult matter. Fumigation is often out of the question, and if moth-balls are used they require frequent renewal. Fortunately, however, the clothing which is used frequently is not subject to injury. Very satisfactory moth-proof bags are on the market, and these come in such sizes that entire garments may be suspended in them.

This paper was discussed by A. W. Morrill, R. W. Doane, E. O. Essig and others.

Chairman A. W. Morrill: The next paper by Mr. G. F. Mozenette will be read by the secretary.

THE CYCLAMEN MITE, TARSONEMUS PALLIDUS BANKS, AND METHODS FOR ITS CONTROL

By G. F. Mozenette, *Corvallis, Oregon*

(Paper withdrawn for publication elsewhere)

Chairman A. W. Morrill: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

ARSENIC AS AN INSECTICIDE

By A. L. Lovett, *Entomologist*, and R. H. Robinson, *Assistant Chemist, Oregon Agricultural Experiment Station*

From the standpoint of physical chemistry, it is generally known that many solid materials have the power of adsorbing certain ions from solutions. By the use of the term "adsorption" we mean the existence of a difference in the concentration of a film surrounding a solid and the concentration of the liquid which bathes this solid. In other words, the solid has a high retaining power for the material in solution. Since, therefore, it is the arsenic of the arsenical sprays that is the active element, if some inert material could be easily obtained in considerable quantities at a reasonable cost, which would adsorb sufficient arsenic to make the substance efficient as a spray, it would be worthy of consideration as an insecticide.

Acting on this hypothesis, a series of experiments were outlined, using lamp black and fuller's earth as adsorbants of arsenic from a water solution of arsenic acid. No determination of the amount of arsenic adsorbed by the lamp black and fuller's earth was made, but water solutions of arsenic acid were prepared from the chemically pure arsenic oxide and to various solutions of different concentrations of arsenic, the carbon black and fuller's earth were added as indicated in the tables. The materials were tested first as to their toxicity for insects, second for burn on apple foliage in the field.

Experiment A

April 9, 1916. Uniform samples of clean, unsprayed apple foliage were used. These were placed in large vials of water in the laboratory and thoroughly and uniformly covered with the spray solution. The foliage was allowed to dry for a period of six hours, after applying the spray, and approximately 500 small tent caterpillars (*M. pluvialis*) were introduced on each.

The materials were prepared according to the following proportions:

No. 1. As_2O_3 at the rate of 5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 5 grams to 300 c.c. H_2O.

No. 2. As_2O_3 at the rate of 5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 5 grams to 300 c.c H_2O.

The foliage of No. 1 was absolutely covered with a thick, heavy coat of black. The caterpillars were restless and dissatisfied, and piled up and suspended themselves from the foliage by webs. Eventually they covered over most of the foliage closely with a fine web. The worms on No. 2 seemed more contented.

But little, if any feeding took place for the first 12 hours; from that time on feeding was general, but restricted. On the morning of April 11, a period of 48 hours, practically all the caterpillars were dead. The amount of foliage devoured was about equal on the two materials and comparatively slight on either. The foliage showed small scattering spots of burn. By April 13, four days after spraying, the foliage on both No. 1 and No. 2 was burned to a crisp.

Experiment B

May 6, 1916. Sprayed apple foliage in laboratory with the following materials, allowed to dry and introduced approximately 1,000 half-grown caterpillars on each.

No. 1. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c H_2O.

No. 2. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.

No. 3. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.

No. 4. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.

As in Experiment A, the caterpillars were restless and refused to eat for a few hours, but soon commenced to feed sparingly.

Table Showing Rate of Kill of Materials

Material	Number Dead			
	May 7	May 8	May 9	Total
No. 1	40	252	454	746
No. 2	21	232	373	626
No. 3	37	531	Practically all dead	568
No. 4	24	259	257	540

Comparatively speaking, but little foliage was devoured. Most of the caterpillars which remained on the foliage were decidedly sick by the morning of May 8, and there was no feeding on the 9th. A number of caterpillars from each series dropped from the foliage without feeding and crawled away, which accounts for the small totals compared with the numbers introduced. The foliage showed small scattered spots of burn the afternoon of May 8. May 10, the burn had spread somewhat, though by no means as general as in Experiment A.

These materials might be termed rapid killers; in comparison with acid lead arsenate and calcium arsenate they apparently have a higher toxicity.[1] However, at these dilutions there is too severe a burn for field use.

[1]Lead arsenate and calcium arsenate tests for toxicity were carried on at the same time.

Experiment C.—Test of Materials in the Field

June 8, 1916. Sprayed the foliage of young apple trees in the field; foliage was thoroughly saturated with the different materials. The test was for burning only, as caterpillars were not available in sufficient numbers to warrant a check being made.

No. 1. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.
No. 2. As_2O_3 at the rate of 1 gram to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.
No. 3. As_2O_3 at the rate of .75 gram to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.
No. 4. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.
No. 5. As_2O_3 at the rate of 1 gram to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.
No. 6. As_2O_3 at the rate of .75 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.
No. 7. As_2O_3 at the rate of 1.5 grams to 1000 c.c. H_2O.
No. 8. As_2O_3 at the rate of .75 gram to 1000 c.c. H_2O.

Report on burn; weather throughout fairly cool and cloudy, with showers.

June 10. Forty-eight hours after applying spray:

Lamp Black Series
- No. 1. Burn general and severe.
- No. 2. Burn general and severe, though probably a little less intense than No. 1.
- No. 3. Burn general.

Fuller's Earth Series
- No. 4. Burn general, though scattered and not particularly severe.
- No. 5. Burn slight.
- No. 6. Burn negligible, only trace.

- No. 7. Burn general, fairly severe.
- No. 8. Burn same appearance and about equal to No. 4.

June 11. Three days after spraying:

Lamp Black Series
- No. 1. Burn spreading, very bad.
- No. 2. Burn spreading, severe.
- No. 3. Burn spreading, severe.

Fuller's Earth Series
- No. 4. Slightly worse than yesterday.
- No. 5. Same as yesterday.
- No. 6. Same as yesterday.

- No. 7. Burn increasing.
- No. 8. Burn increasing.

June 24. Sixteen days after spraying:

Lamp Black Series
- No. 1. Foliage burned until about all has dropped.
- No. 2. Foliage burned until about all has dropped.
- No. 3. Foliage burned, very bad.

Fuller's Earth Series
- No. 4. Burn about same as on June 11, while probably too pronounced for general spray work, is not really serious.
- No. 5. Slightly more than on 11th, but not really bad.
- No. 6. O. K., burn comparatively slight.
- No. 7. Burnt to a crisp.
- No. 8. Burnt to a crisp.

Conclusions

Under field conditions lamp black is not practical, the black color probably absorbs heat and increases the burn. That the presence of an adsorbant has possibilities is clearly shown in a comparative study of the burn between Nos. 5 and 7, and between Nos. 6 and 8. Nos. 5 and 6, having fuller's earth as an adsorbent, giving comparatively little burn. Nos. 7 and 8, with the same dilution of arsenic, but without an adsorbent, burned all the foliage absolutely to a crisp. Conclusions based on one season's observations, both as to toxicity for insects and as to amount of burn indicate that there are possibilities in the use of adsorbents with arsenic and further trials are planned on a larger scale for the coming season. Estimates based on insufficient data would indicate that if such a material may be used commercially it will reduce the cost of arsenical sprays about two-fifths.

Meeting adjourned until 2 p. m. the following day.

Meeting called to order by Chairman A. W. Morrill at 2 p. m., Friday, April 6, 1917.

Chairman A. W. Morrill: The first on the program is a symposium on mail shipments of plants and plant products. This will be opened by myself and then a general discussion will follow.

Chairman Morrill: I have long held the view that postal shipments are proportionally more dangerous as regards the transmission of all plant pests than shipments by express or freight. The results of the first year's experience of parcel post shipments in Arizona tend to confirm this view. Altogether we inspected 543 of these shipments and found that 4.4 per cent contained infested or diseased plants. During the same period 2,432 freight and express shipments of plants were inspected with the result that only 2.5 per cent were found to contain infested or diseased plants. The pests found in parcel post shipments were fully as important on the average as the pests found in freight and express shipments. During the nine months' inspection of parcel post shipments the following pests were found by our inspectors: Soft brown scale (*Coccus hesperidum*) 1 shipment; purple scale (*Lepidosaphes beckii*) 1 shipment; rose scale (*Aulacaspis rosae*) 1 shipment; undetermined scales (immature) 3 shipments; plant lice

(undetermined) 6 shipments; thrips (undetermined) 3 shipments; red spider (*Tetranychus bimaculatus*) 4 shipments; citrus white fly (*Dialeurodes citri*) 2 shipments; moth larva (undetermined) 1 shipment; tortoise shell beetle larvæ on sweet potato (Cassida sp.) 1 shipment; crown gall (*Bacterium tumefaciens*) 3 shipments.

One parcel post shipment contained citrus trees from a section against which a quarantine is maintained and one contained currants and gooseberries from the district covered by the Federal Horticultural Board's request to nurseries dated March 22, 1916, to discontinue shipments into certain Western territory owing to the danger of transmitting white pine blister rust.

I am particularly apprehensive of the danger of the pink bollworm of cotton becoming established in this country and afterwards spread beyond hope of eradication by means of parcel post shipments of cottonseed. I have reason to believe that a good many plant shipments coming into the State of Arizona by parcel post have not been held for inspection by the postmasters. The particular difficulty in maintaining an efficient inspection service for parcel post shipments of plants lies in the lack of personal responsibility of the postoffice employees for the packages which pass through their hands. It has been our experience that whenever any unnecessary delay in delivery after inspection or failure to hold a plant shipment for inspection comes to our attention, it is impossible to place the responsibility among the postoffice employees at the offices concerned. Freight and express shipments however are all handled in such a manner that it is almost invariably possible to trace the blame for irregularities to the proper sources. I believe that parcel post shipments of plants are extremely dangerous to the fruit growing and farming interests of the country and I hope that the time will soon come when all shipments of plants by parcel post will be prohibited as has already been done with respect to mail importations from foreign countries.

The discussion following was general and nearly every member present participated.

CHAIRMAN A. W. MORRILL: The next paper will be read by W. M. Davidson.

The Division of Entomology, North Carolina Department of Agriculture, has entered into agreement with the Bureau of Plant Industry whereby it is planned to employ a man, suitable to both parties, for one or more months' scouting work in the white pine region of the state in search of the pine blister rust disease,—this to be supplemented by special attention to five-leaved pines and Ribes in the nursery inspection work the coming summer. The blister rust disease is not now known to be present in North Carolina.

THE REDDISH-BROWN PLUM APHIS (RHOPALOSIPHUM NYMPHÆ LINN.)[1]

By W. M. Davidson, *Deciduous Fruit Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, Sacramento, Cal.*

Distributed in many of the plum and prune districts of California is a plump reddish-brown aphid. This aphis is generally confined to a few trees in an orchard and occasionally infests apricots and almonds. It attacks plums of the *domestica* type along with the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), and those of the Asiatic type along with *Aphis cardui* L. In the East it also occasionally infests peaches.

The insect is apparently of European origin and was known to Linnæus. Well-known to later European and American entomologists, it has been recorded from many parts of Europe and from Maine, New York, Maryland, District of Columbia, Virginia, Pennsylvania, Nebraska, Illinois, Iowa, Colorado and California and is probably distributed throughout the United States. It also occurs in Ontario and Japan.

The species is of especial interest in that it is double-hosted, spending the winter and spring on fruit trees and the summer and early fall on a large variety of water plants, leading on them a semi-aquatic existence. In California summer forms have been recorded from *Polygonum*, *Typha*, and an unidentified pondweed, elsewhere they have occurred among others on water-lily (*Nymphea*), pondweed (*Potamogeton*), Calla and water-plantain (*Alisma*).

Biology and Habits

The stem mothers hatch from winter eggs unusually early in the season, sometimes before the buds of the trees perceptibly swell. In 1916 at Walnut Creek, Cal., hatching began about February 10, on Myrobalan plums, and the earliest aphids matured before February 26. The year following at Sacramento eggs hatched as early as February 15 on seedlings whose buds were swelling, and the aphids matured March 6. Hatching on French prunes occurs at about the time the buds swell perceptibly, the early stem mothers maturing at the time of full bloom. Eggs continue to hatch for two or three weeks, the young stem mothers exhibiting a gregarious tendency. The second generation aphids mature about as early as the stem mothers of the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), roughly between March 20 and April 15. The spring forms feed chiefly on the tender

[1] Published with the permission of the Secretary of Agriculture.

stems, and later on the leaf and fruit petioles and during April multiply rapidly. Winged forms appear first the second week in April and may be found until July. The colonies decline throughout May and June, both through the production of winged migrants and through the increasing activity of natural enemies.

Summer colonies are found from May to October and are often very large, the individuals being very prolific. Natural enemies again exact heavy toll.

Fall migrants are produced from the middle of October to early December, the majority during the first half of this period. In 1915 at Walnut Creek, Cal., these began to arrive on the winter host October 25, in the following year on October 20. The fall migrants feed on twigs and petioles and deposit the sexed females. Winged males arrive while the females are growing and settle down on the twigs beside them. After a development period of about 20 days the females mature, copulation occurs and shortly after the females place winter eggs in the axils of the buds of the following year. The egg is rather elongate, bare, at first shining green, in a few days turning jet black.

This aphis is preëminently a twig-feeder and the fact that the stem mothers hatch so early and feed exposed points to an easy control should the species ever become of sufficient economic importance to warrant combative measures. Even on many of the summer hosts the twigs and flower stalks are preferred to the leaves.

Recognition Characters

General Color.—Reddish-brown varying to dark olive and dark greenish-brown. Newly-hatched stem mothers are green, soon changing to a dark slate-colored hue, lightly dusted with gray pruinose meal. Aphids of the second generation are yellowish-brown when born, reddish-brown in later stages. Sexual females crimson.

The head and abdomen of the pupa bear white pulverulence.

In the winged forms the head, thoracic lobes, scutellum and sterna are shining black, prothorax brown with yellowish sutures. The stigma and insertions of the wings are yellowish gray, the veins brown; the first and second discoidals thicker than the other veins. Many individuals have a series of lateral sub-circular brown areas, and besides these the males have brown cross-bands on the abdomen.

The base of the third antennal joint, basal beak joints, extreme base of femora, basal half to three quarters of tibiæ are yellowish-gray, elsewhere the appendages are dark gray, dark brown or black. Cauda gray, cornicles brownish-black with base paler.

Structure.—Antennæ placed on short frontal tubercles, shorter than the body (except in the male); joint III about four-fifths as long as the spur of joint VI, but in some instances III is but three-fifths as long as spur and again they are sub-equal; in apterous forms there are no sensoria except the usual terminal on joints V and VI; in the winged spring migrants joint III has from 17 to 22 circular sensoria distributed almost the whole length of the joint and joint IV has from 0 to 3 circular sensoria. In the winged fall migrant the number of sensoria on joint IV varies from 2 to 11, the usual number being 3. The male antenna bears on joint III about 30, on IV about

16, and on V about 12 small circular sensoria arranged irregularly; joint VI having only the usual "terminal" group. The oviparous female bears on her thickened hind tibiæ numerous small circular sensoria.

The beak reaches to or a little beyond the third coxæ. The stigma of the fore-wings is rather elongate, the stigmal vein with a shallow basal curve thence continued almost in a straight line to the margin of the wing. The cornicles are imbricated and club-shaped, constricted about basal third and again less markedly close to the apex, their shape differing according to the form, those of the spring wingless and oviparous female being less clubbed than in the other forms. The cauda is upturned in nature, about two-fifths as long as the cornicles, its apical portion quite noticeably narrowed.

A normal armature of hairs is found in all forms.

Lateral tubercles are present on the pro-thorax in all forms; on abdominal segments 1 to 7 inclusive in the winged, on abdominal segments 1 and 7 only in the wingless forms.

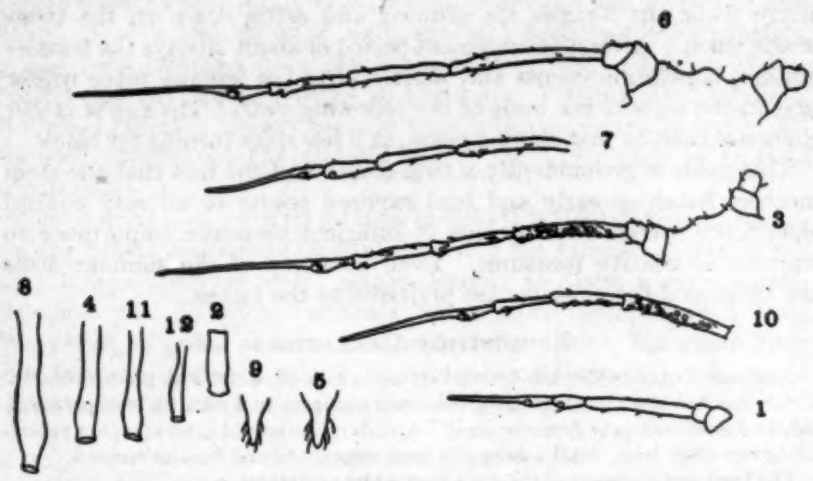

Fig. 19. *Rhopalosiphum nymphæ* Linn.: Fig. 1, stem mother, antenna; 2, stem mother, cornicle; 3, spring migrant, head and antenna; 4, spring migrant, cornicle; 5, spring migrant, style (cauda); 6, summer apterous, head and antenna; 7, summer apterous, antenna (apical segments) from smaller individual; 8, summer apterous, cornicle; 9, summer apterous, style; 10, fall migrant, antenna apical segments; 11, fall migrant, cornicle; 12, male, cornicle. All drawn to same scale.

COMPARATIVE MEASUREMENTS (MM.)

Form	Antennæ lengths						Cornicles length	Cauda length	Beak length	Wing length
	III	IV	V		VI					
			base	spur	base	spur				
Stem mother	*.30 to .33	.095 to .105	.06 to .10	.20 to .23			.20 to .22	.13 to .15	.53	—
Spring apterous generation (Plum)	.30	.18 to .225	.145 to .195		.095 to .125	.29 to .335	.29 to .33	.17 to .18	.52	—
Spring migrant	.33 to .44	.30 to .37	.20 to .24		.105 to .130	.38 to .46	.30 to .39	.15 to .18	.60 to .63	3.10 to 4.0
Summer apterous form (Summer hosts)	.28 to .39	.22 to .37	.15 to .23		.11 to .13	.36 to .39	.37 to .50	.15 to .17	.60 to .63	—
Fall migrant	.32 to .38	.22 to .29	.18 to .22		.09 to .14	.27 to .45	.30 to .37	.15	.65	3.05 to 3.4
Male	.33 to .39	.24 to .28	.19 to .23		.09 to .11	.33 to .46	.22 to .28	.09 to .11	.61	2.35 to 2.72

*Joint III evidently represents combined III and IV of later forms.

The discussion following was by R. W. Doane, H. E. Burke and E. O. Essig.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Geo. P. Gray.

LABORATORY AND FIELD TESTS OF CALIFORNIA PETROLEUM INSECTICIDES

By GEO. P. GRAY, *Berkeley, Cal.*, and E. R. DEONG, *Davis, Cal.*

(Withdrawn for publication elsewhere)

This paper was discussed by A. W. Morrill and other members of the house.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Stanley B. Freeborn.

THE RICE FIELDS AS A FACTOR IN THE CONTROL OF MALARIA

By STANLEY B. FREEBORN, *Instructor in Entomology, University of California*

The introduction of rice culture into the Sacramento and San Joaquin Valleys of California has called forth much comment as to its possible influence upon the increase and control of malaria which is already endemic in both valleys. Rice was first grown commercially in California in 1912 when 1,400 acres were planted at Biggs in the Sacramento Valley. The acreage has increased at the rate of over 100 per cent a year since that time until 1916 saw about 75,000 acres under cultivation. The industry is an exceedingly fortunate one owing to the fact that land rendered useless by previous cropping or unfit for other crops on account of faulty texture has been used for rice, thus adding materially to the state in wealth.

The cultivation of rice demands that the entire acreage be flooded to the depth of four or five inches with water stagnant or in a gentle current for a period varying from 145 to 160 days beginning about June first.

Theoretically, at least, these large bodies of standing water, well areated by a gradual addition of water and the presence of the growing rice, should form ideal breeding places for malaria-bearing mosquitoes. However, there is a deep grounded belief among those who deny the ability of the rice fields to produce mosquitoes, that there is an "essential something" in the rice fields that prevents mosquito breeding. This "essential something" is explained by another mystery,—the ecological factors governing the habitat of the different species of mosquitoes. Just as salmon, brook-trout, and steel-heads choose different breeding grounds, so the different species of anophelines invariably deposit their eggs in locations where a given set of determining factors are present. Some, it is true, have a wide range of selection but the majority are limited to very definite locations. For example, *A. malefactor*, a tropical anopheline, breeds almost exclusively in hollow tree trunks while *A. ludlowii* is limited to brackish or salt tide water. Again *A. febrifer*, a Philippine malaria carrier finds its ideal habitat at the edge of running streams and is seldom present in stagnant pools as is the case with our domestic anophelines. The statement that California rice fields will not furnish breeding grounds for malaria-bearing mosquitoes is based solely on the empirical application of the knowledge that in certain parts of the world, the hypersusceptible anophelines of the district do not find their natural breeding places in the rice fields.

Barber has shown that the rice areas of the Philippines are singularly free from malaria due to the fact that the typical rice field anopheline, *A. rossi*, is only a weak and somewhat doubtful carrier of malaria while the intensive carrier, *A. febrifer*, is a stream breeder whose breeding places are destroyed with the introduction of rice paddies. He follows these remarks with the statement that " . . . in some parts of the Philippines the further development of rice culture may result in the diminution of malaria."

Watson, writing of malaria conditions in the Federated Malay States, comments on the absence of malaria in the rice districts and its abundance in the hill country and suggests rice culture as an anti-malarial measure.

Kendrick, working in central India, observed that the rice districts on the broad open plains were practically free from malaria but that when shade such as that afforded at the edge of the jungles was present the species of anopheles changed and malaria was present. In all of these instances of malaria free rice districts, the anophelines present lacked the ability to transmit malaria or were relatively weak carriers.

From these findings of men who have dealt with the problem in various countries and under different conditions, the only safe deduction that can be made is the fact that each district requires separate investigation regardless of apparent similarity. The Californian problem can not be settled by Indian or Philippine investigations or even by those under way in our own southern states.

In order to determine, therefore, the relative importance of the rice field mosquitoes as a factor in malaria control, it is necessary to ascertain (1) what anophelines breed in the rice fields and the pools adjacent to and caused by them, (2) their susceptibility as malaria carriers, and (3) their relative abundance.

In the Sacramento Valley rice fields two anophelines find reasonably satisfactory breeding grounds judging from the number of larvæ taken. *Anopheles occidentalis* D. & K. and *Anopheles pseudopunctipennis* Theob. are both present in large numbers, making up about one half the mosquito population of the district. Probably 70 to 80 per cent of these two species find their breeding places in the pools attendant to the rice fields and caused by seepage, overflow and faulty water regulation. The other 20 to 30 per cent breed in the rice fields proper in the shallow water near the contour checks.

A. occidentalis is a recently named species which was previously considered to be *A. quadrimaculatus*, the principal eastern and southern malaria-carrier. Nearly a thousand specimens of *A. occidentalis* in our collection show all stages of resemblance to *A. quadrimaculatus* from those fairly well defined to those that are practically identical

with the latter. No experimental work has been done to show that *A. occidentalis* is susceptible to the parasite of malaria but since it is one of only two anophelines that are found in highly malarial districts and the other,—*A. pseudopunctipennis*, is only slightly susceptible, it seems reasonable to believe that it is the chief carrier. To this circumstantial evidence might be added the additional reminder of its close connection and perhaps synonomy with *A. quadrimaculatus*, a proven carrier of malaria in many parts of the United States.

Beyer and his associates stated that *A. quadrimaculatus* could be infected with the tertian and quartan types of malaria but not with estivo-autumnal. However, Hirshberg succeeded in infecting eight out of 48 specimens of *A. quadrimaculatus* that were allowed to feed on a volunteer suffering with the estivo-autumnal fever. Von Esdorf, in a later paper, states conclusively that *A. quadrimaculatus* is susceptible to all three types of malaria.

A. pseudopunctipennis has always been looked upon doubtfully as a malaria carrier. Darling succeeded in infecting four out of 27 of this species with estivo-autumnal parasites, but a very small series of experiments with the parasites of the tertian and the quartan types of fever proved negative.

The apparent contradictions of the different findings regarding the infectivity of the same species of mosquito, is by no means limited to those above stated. The same type of contradictions is prevalent throughout the literature of infectivity experiments. This may be due in some cases to faulty technique, confused nomenclature, or the failure to state what type of malaria parasites were used for the experiment, for different types of malaria are carried by different species of *Anopheles*. Many times mosquitoes have been listed as non-malaria carriers on the basis of experiments with one type of malaria although they were the most important carrier of another type. Mitzmain has proved this in showing that *A. punctipennis* is a strong carrier of tertian fever but absolutely negative to estivo-autumnal. Another source of error seems to be in the failure to consider ecological factors. Some species seem capable of carrying malaria in one district while repeated attempts to infect them in other portions of the country with the same type of malaria invariably result negatively. Majoribanks states that *A. listoni* is the chief carrier in parts of Bengal and although occurring in large numbers in western India has never been found infected despite the fact that malaria is endemic there.

Considering both the circumstantial and experimental aspects of the California problem, I feel that we can safely say that in the rice districts *A. occidentalis* is the important carrier with perhaps a few scattered infections due to the agency of *A. pseudopunctipennis*.

These two mosquitoes breed in the rice fields close to the contour checks which wind about through the fields to hold the water at the different levels, their abundance depending largely on the character of the rice stand. A heavy and uniform stand of rice, growing well up to the checks, produces relatively few mosquitoes while a sparse stand with irregular growth at the checks generally breeds anophelines in large numbers. Far more important than the rice fields proper, however, are the overflow pools of surplus water. These vary in size from small wayside pools to vast water-soaked sloughs that lack the natural drainage to keep them dry. These bodies of water, both large and small, breed enormous numbers of mosquitoes and are entirely unnecessary. Careful construction of the irrigation ditches together with an intelligent and economical use of water would entirely eliminate them in a majority of cases.

The irrigation of the rice fields does not begin until May. The mosquitoes, however, begin active breeding in March and April, utilizing neglected pools of standing water. Again after the water is drawn from the rice fields in October, the mosquitoes continue to breed actively until the latter part of November, again utilizing neglected and useless pools. If, therefore, all possible breeding pools could be controlled before and after the rice season as well as the outside pools that occur as results of rice cultivation during the season, the mosquito population would be so considerably reduced that the number breeding in the rice fields proper would be almost negligible.

The best agricultural methods demand that the land used for rice and the adjacent territory be as nearly dry as possible before the crop is planted. Again the irrigating water should be on the fields only just long enough to mature the crop. As the rice approaches maturity every detail should be undertaken to ensure immediate drainage away from the fields at the moment that the crop matures. The fields should then remain dry until they are naturally irrigated by the winter rains. Thus it will be seen that optimum agricultural methods coincide with optimum mosquito control measures and when the industry has become scientifically standardized the mosquito question will be controlled automatically to a large extent.

Unfortunately, a large percentage of the rice cultivation is carried on by tenant farmers whose only vision is to reap the speediest and most lucrative returns. The result has been as might be expected, the irrigation ditches are badly maintained, the land is robbed of its chemical constituents by poor agricultural methods and the profligate use of water. Perhaps the most striking phase is the living conditions of the workmen. The labor is transient and many of the shelters are mere shacks lacking any attempt to exclude mosquitoes with the result

that infected laborers rapidly spread their infection throughout the district by means of the numerous mosquitoes.

The control of those mosquitoes that breed in the rice fields proper is an extremely difficult matter. Larvicides that are efficient in mosquito control, such as oil, salt, etc., are detrimental to the rice. Fish are not successful owing to the difficulty in keeping the fields stocked and their inability to feed in the shallow water inhabited by the mosquitoes. Dragonflies as adults may be looked upon as a check but not as a control. The dragonfly larvæ, even in the presence of an abundant supply of mosquito larvæ and pupæ, prefer cannabalism.

Theoretically, malaria can be controlled in two ways. If everyone in a malarial district could be cured by means of quinine treatment the mosquitoes would have no point at which to become infected or if everyone would take a daily prophylactic dose of quinine, the chances of infection even though bitten by an infected mosquito would be materially lessened and the death of the last infected mosquito would see the community free from malaria. Secondly, if all malaria-bearing mosquitoes were eliminated there would remain no transmitting agency to convey the disease from the sick to the well and again malaria would disappear from the community with the recovery of the cases infected at the time of the elimination.

Experience in different lines of preventive medicine points out the difficulty of administration of universal quinine treatment. In this country of personal liberty it would be practically impossible to force any such measure upon the people no matter how beneficial it might eventually be. On the other hand, those who have had experience with anti-mosquito campaigns know the difficulties attendant to nominal *control*, to say nothing of the *elimination* of mosquitoes from any given district.

The logical control of malaria in the rice districts of California rests in the careful application of a combination of these two methods,—zealous anti-mosquito campaigns together with careful quinine treatment or prophylaxis.

1. The rice field becomes an economic factor in the control of malaria in endemic localities when they offer breeding grounds to large numbers of anopheline mosquitoes that are capable of transmitting the malaria parasites. This is true in the California rice fields.

2. The pools of standing water outside the rice fields proper, but owing their existence to faulty agricultural methods of the rice growers, are far more important than the rice fields proper.

3. The control of breeding places outside the rice fields before, after and during the rice season combined with an application of those methods of rice cultivation that are recognized as agriculturally sound would substantially control the mosquitoes.

4. Larvicides or predaceous animals are of little use in the rice fields.

5. Organized quinine prophylaxis and treatment together with anti-mosquito precautions would decrease materially the incidence of malaria.

Bibliography

Barber, M. A.; Raquel, Alfonso; Guzman, Ariston; and Rosa, A. P. Malaria in the Philippine Islands. Phil. Jour. of Sci., vol. X, No. 3, Sec. B, pp. 177–247.

Beyer, G. E.; Pothier, O. L.; Couret, M.; and Lemann, I. I. Bionomics, experimental investigations with *Bacillus sanarelli* and experimental investigations with malaria in connection with the mosquitoes of New Orleans. Report of the Mosquito Commission to the Orleans Parish Med. Soc. New Orleans Med. & Surg. Jour., vol. 54, pp. 419–480.

Darling, S. T. Studies in relation to Malaria. Reprint of Dept. of Sanitation, Isthmian Canal Commission.

Herms, W. B. Medical and Veterinary Entomology. Macmillan Company, 1915.

Hirschberg, L. K. An *Anopheles* mosquito which does not transmit malaria. Bull. Johns Hopkins Hospital, vol. 15, No. 155, pp. 53–56.

Kendrick, W. H. Malaria and Rice Cultivation. Proc. of All-India San. Conf., Lucknow, vol. IV, pp. 64–70.

Majoribanks, J. L. Report on certain features of malaria in the island of Salsette. Proc. of Third All-India San. Conf., Lucknow, vol. IV, p. 23.

Mitzmain, M. B. The transmission of tertian malaria by *Anopheles punctipennis* Say. U. S. Public Health Reports, vol. 31, No. 19, May 12, 1916.

Von Ezdorf, R. H. Anopheline Surveys. Reprint No. 272, Pub. Health Reports. April 30, 1915.

Watson. Cited by Barber et al., loc. cit.

Chairman A. W. Morrill: It will probably be best to wait and discuss this paper along with the next one which is to be read by Prof. W. B. Herms.

A STATE-WIDE MALARIA-MOSQUITO SURVEY OF CALIFORNIA

By William B. Herms, *Associate Professor of Parasitology, University of California, and Consulting Parasitologist, of the California State Board of Health*

The great state of California, bathed for many miles by the waters of the Pacific Ocean, favored by a semi-tropical climate, well deserves to be called the nation's health resort and playground, but while Burbank has shown how the spine-covered cactus may be made smooth to the touch, and we now have under cultivation many acres of spineless cactus, there still thrives in many parts of the state the festive mosquito, not yet shorn of its beak nor devoid of its ability to transmit malaria. Evidenced by letters in my possession there are some per-

sons who, cognizant of the prevailing dry summer conditions of California, would believe this state largely free from these pestiferous and noxious insects. True it is that the great valleys of California have little or no rainfall during the summer months, but this very fact implies the necessity for ample water to produce California's vast acreages of agricultural products. This water, supplied by extensive irrigation systems, is one of the important factors in the production of mosquitoes. To this must be added numerous more or less stagnant summer pools, due to our many rapidly receding creeks and streams. Furthermore, water from the melting snows of the Sierras continually flows down the mountain sides and spreads out here and there over the meadows of the foothills. Thus even though there may be little or no rainfall for several months during the summer, there is ample water and in such condition that the breeding of mosquitoes is favored. The fact that California is bounded for many miles by the Pacific Ocean adds many acres of salt marsh to its mosquito-producing areas. Thus the mosquito problem of the state involves both fresh water and salt marsh species.

That malaria has existed in California for at least sixty years is evident from the following quotation from the writings of Edwin Bryant,[1] one time alcalde of San Francisco and an extensive traveller in California in 1846–1847, viz.: "On some portions of the Sacramento and San Joaquin Rivers, where vegetation is rank and decays in the autumn, the malaria produces chills and fever, but generally the attacks are slight and yield easily to medicine" (page 452).

That mosquitoes abounded at that time is evidenced by the following quotation also from Bryant: "By this change we were relieved from the annoyance of mosquitoes, which have troubled us much during the night at our encampment." This quotation is taken from an entry made between the 3rd and 7th of September 1846 while encamped at Sutter's Fort (p. 273).

The first effort on the part of the University of California to assist in the abatement of the mosquito nuisance was made in Marin County in the vicinity of San Rafael at the request of Mrs. George T. Page of the San Rafael Improvement Club. This request is dated April 5, 1903. An investigation was made by Professor C. W. Woodworth and assistants with the result that oil was applied according to recommendations to certain salt marsh areas responsible for the trouble. This was followed by the employment of Mr. A. L. Ashman during the spring and summer of 1904 for the purpose of mosquito abatement.

In March 1904 the Burlingame (San Mateo County) Improvement

[1]Bryant, Edwin, 1848. What I saw in California. D. Appleton & Co., New York (480 pp.).

Club invited Professor Woodworth to make a similar investigation of the mosquito problem in the vicinity of Burlingame. Professor H. J. Quayle was detailed to organize and conduct the campaign. Here again the main trouble was traceable to the neighboring salt marshes. During the spring and summer of 1905 Quayle, assisted by students from the University of California, waged a systematic anti-mosquito campaign with marked success.[1] Considerable permanent corrective work was undertaken together with a systematic study of the mosquitoes of that vicinity. During the mosquito seasons of 1911 and 1912 a salt marsh mosquito campaign was conducted by the writer with the help of students in the vicinity of Bay point in Contra Costa County under the patronage of the Smith Lumber Company.

The writer first became definitely identified with the mosquito abatement problems of California in December, 1909, when he received a letter from Penryn, Placer County, requesting that an investigation be made of the malaria-mosquito situation in that vicinity. This investigation resulted in organising a systematic campaign against mosquitoes during the spring and summer of 1910, terminating in a marked reduction of malaria, particularly in school children. This campaign deserves the distinction of being the first organized anti-malaria crusade in the state. The campaign in Penryn had hardly begun when citizens of Oroville, Butte County, requested that a similar campaign be organized there. These two campaigns are described in detail in the writer's book on "Malaria,—Cause and Control."[2]

The movement spread rapidly so that within the following two years crusades against malaria-bearing mosquitoes had been organized in a number of localities from Bakersfield in Kern County to Los Molinos in Tehama County.[3] One of the chief obstacles from the very beginning has been the matter of securing adequate funds to carry out an efficient crusade. The expenses had thus far been largely borne by a few public-spirited citizens. Hence very early in the work a plan was sought whereby funds might be secured on a more equitable basis, with the result that finally, after several failures, an act of the legislature was approved by the governor on May 29, 1915, known as the "Mosquito Abatement District Act."

This act provides for the formation, government, operation and dissolution of districts, to facilitate the extermination of mosquitoes,

---

[1]Quayle, H. J., 1906. Mosquito Control. University of California Agric. Exp. Sta. Bulletin No. 178 (55 pp.).

[2]Herms, W. B., 1913. Malaria,—Cause and Control. XI+163 pp. Macmillan Company, New York.

[3]Herms, W. B., 1915. Successful Methods of Attack on Malaria in California. California State Journal of Medicine, vol. XIII, No. 5, pp. 185–189.

flies and other insects; and to provide for the assessment, levy, collection and disbursement of taxes therein. It provides that such tax must not be greater than sufficient to raise the amount estimated by the board of trustees of the district, appointed by the county supervisors, and must not be in excess of ten cents on each one hundred dollars of taxable property in such district.

The first district to be organized under the new law was the San Mateo District, the second being Marin County District No. 1, both involving salt marsh areas. These two districts are now in charge of Mr. N. M. Stover, a graduate of the University of California. A second salt marsh district has been organized in San Mateo County, known as the Pulgas District. The first inland district to be organized involving fresh water mosquitoes of the malaria-bearing type was at Bakersfield,—the Doctor Morris District. Oroville (Butte County) has a well organized district while the Los Molinos District (Tehama County) is ready for operation and Riverside (Riverside County) and Yolo County are now in process of formation.

The act makes it possible to include both incorporated and unincorporated territory or portions of both in the same district, thus protecting communities which draw their supply of mosquitoes very largely from the outskirts which may be outside the corporate limits.

Fourteen species of mosquitoes for California were listed by Quayle[1] in 1906, viz.: *Anopheles punctipennis* Say, *Anopheles maculipennis* Meig., *Anopheles franciscanus* McCr., *Psorophora ciliata* Fabr., *Ochlerotatus varipalpus* Coq., *Ochlerotatus lativittatus* Coq., *Ochlerotatus sylvestris* Theob., *Lepidoplatys squamiger* Coq., *Culex tarsalis* Coq., *Culex territans* Walk., *Culex pipiens* L., *Theobaldia annulatus* Schran., *Theobaldia incidens* Thom., and *Culiseta consobrina* Desv. At the present writing (1917) we have listed 27 species, viz.: *Anopheles punctipennis* Say, *Anopheles quadrimaculatus* Say (=*A. occidentalis* Dyar and Knab), *Anopheles pseudopunctipennis* Theob. (=*A. franciscanus* McCr.), *Aedes varipalpus* Coq. (=*Ochlerotatus varipalpus* Coq.), *Ædes onondagensis* Felt (=*Ochlerotatus lativittatus* Coq.=*Ædes quaylei* D. and K.=*Ædes curriei* Coq.), *Ædes taeniorhychus* Wied. (=*A. damnosus* Dyar), *Ædes sylvestris* (Theob.), *Ædes squamiger* (Coq.) (=*Lepidoplatys squamiger* Coq.), *Ædes vittatus* Theob., *Ædes increpitus* Dyar, *Ædes palustris* Dyar, *Ædes cataphylla* Dyar, *Ædes ventrovittus* Dyar, *Ædes hexodontus* Dyar, *Ædes tahœnsis* Dyar, *Ædes sansoni* D. and K., *Ædes pallatus* Coq., *Culex tarsalis* Coq., *Culex territans* Walk, *Culex quinquefasciatus* Say (=*C. cubensis* Dyar=*C. fatigans* Wied.), *Culex stigmatosoma* Dyar, *Culex erythrothorax* Dyar, *Culex comitatus* D.

[1]Quayle, H. J., 1906 (*loc. cit.*).

and K., *Culiseta incidens* Thom. (=*Theobaldia incidens* Thom.), *Culiseta inornatus* Will. (=*Culiseta consobrina* Desv.), *Culiseta maccrackenæ* D. and K., *Uranotænia anhydor* Dyar (from larva only at San Diego by Dyar). Three other species are doubtful for California, *Psorophora ciliata* Fabr., *Ædes calopus* Meig and *Culex pipiens* L.

Malaria in California

The extent and prevalence of malaria in California is best described by Snow[1] viz.: "The United States mortality reports show that in 1909 California had one eleventh of all the deaths from malaria in the registration area, which includes eighteen states, and ranked second in number of deaths for a single state. Indiana was first with 125 deaths, New York third (95 deaths), Ohio fourth (75 deaths), Pennsylvania fifth (50 deaths). In proportion to population California outranks all other states in this area. Within the state 66 per cent of the deaths occurred in ten counties extending in an almost unbroken chain along the base of the Sierra Nevada Mountains. The total population for these counties (1910 census) is 326,896. Malaria, therefore, causes five times as many deaths per 100,000 of population as the average for the United States registration area. In these ten counties (Shasta, Tehama, Butte, Yuba, Placer, Sacramento, Amador, San Joaquin, Fresno, Kern) the 1909 death-rate from malaria was one death to 4,400 people. A second group of ten counties (Trinity, Sutter, Yolo, Napa, Contra Costa, Calaveras, Stanislaus, Merced, Tulare, and Kings) contiguous to those of the first group shows one death to each 15,820 of population. A third group of ten counties (San Francisco, San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito, Monterey, San Luis Obispo, Santa Barbara, and Los Angeles) forming a chain along the coast shows one death to each 57,614 of population. Twenty-eight, or almost 50 per cent of the counties show no malarial deaths. Excluding the counties of San Francisco and Los Angeles, there remains the fact that two thirds of the population live in counties which contributed all the deaths from malaria, while one third of the population of the state live in counties which had no malarial deaths in 1909. A further study of the distribution of malaria in California shows Butte County 15 per cent, Sacramento County 10 per cent, San Joaquin 9.8 per cent, Fresno 6.2 per cent, Shasta 5.4 per cent of the deaths of 1909. Three counties, with only one sixteenth of the total population of the state, have more than one third of all the deaths from malaria.

"If the counties bordering the Sacramento and San Joaquin valleys

[1]Snow, William F. Malaria. California State Board of Health Monthly Bulletin, pp. 276–279 (Nov., 1910).

and sending tributary streams to these two great rivers be divided by a line from the Suisun Bay to Mokelumne Peak it will be found that eleven counties to the north of this line show 50 per cent of the deaths from malaria in 1909, and thirteen counties to the south of the line show 30 per cent of the deaths from this cause. In other words, the Sacramento and San Joaquin valleys contributed 80 per cent of all the deaths from malaria within these valleys. The following figures are significant: Nine of the twenty-four counties had 75 per cent of the deaths, or 60.6 per cent of the deaths for the entire state. These nine counties fall into three groups, (1) Placer, Sacramento, San Joaquin, with 25 per cent of the deaths and a population of 136,774; (2) Butte, Tehama, Shasta, with 24 per cent of deaths and a population of 57,622; (3) Fresno, Tulare, Kern, with 11.6 per cent of deaths and 148,812 population.

"Reducing these figures to terms of 100,000 population and comparing with the United States census average of 4.8 for the entire registration area, the Butte-Tehama-Shasta area shows 46.8 deaths per 100,000 population; the Placer-Sacramento-San Joaquin area shows 20.4 deaths per 100,000; and the Fresno-Tulare-Kern area shows 8.9 deaths per 100,000 population."

The above report on malaria conditions in California is not based on endemic indexes and has consequently been regarded by some as of comparatively little value. While the writer had not undertaken a systematic study of large numbers of blood smears, enough of these had been examined both prior to and after Snow's report that he is convinced that endemic indexes would have shown the statements above quoted practically correct. As it is, control work already accomplished would alter the situation.

Meyer[1] states "We examined the blood of 272 children in Gridley (Butte County) and of 364 children in Chico (Butte County) and found a tertian infection in each place (one seventeen-year-old Japanese boy in Gridley and one nine-year-old girl in Chico)." This could not well be regarded as a representative index, the work having been done early in the season (May 17–31, 1915) and included only a portion of the school children. A very much more significant index was made by Kelley[2] at Redding (Shasta County) where an index was made in October, 1915, based on 435 blood smears taken from as many school children showed thirty-five infected or an index of 8 per cent, there being 17 cases of aestivo-autumnal, 17 cases of tertian and

[1] Meyer, Karl F. The Malaria Problem. Trans. of the Commonwealth Club of California, vol. XI, No. 1, pp. 21–26 (March, 1916).

[2] Kelley, Frank L. Endemic Index of Malaria in the Northern Sacramento Valley. Journ. of the Amer. Med. Assoc. (In press).

one quartan. For comparison the endemic malaria indexes for several states after von Ezdorf[1] are here quoted, viz.: Alabama 11.4, Arkansas 10.1, North Carolina 7.8, South Carolina 11.9, Mississippi 31.2, Virginia 9.3. No doubt the endemic index for Redding (Cal.) would have been greater but for some mosquito control work which had been instituted during the previous two or three summers.

A Systematic Mosquito Survey

During the course of the seven years preceding the summer of 1916, the writer had gained some knowledge of the mosquitoes of California because of his extensive field observations, but as yet no systematic survey of the situation had been undertaken. Anopheline surveys such as were carried out by the United States Public Health Service in certain of the southern states under the direction of von Ezdorf[2] are fundamental to successful malaria control measures.

A notable advance was made during the summer of 1916 in our knowledge of the malaria-mosquito situation in California and consequently we believe decided progress has been made in the control of malaria in the state. On February 23, 1916, in the office of the president of the California State Board of Health, the writer in conference with the president and secretary of the State Board of Health and the director of the Bureau of Communicable Diseases presented the matter of a mosquito survey as the most urgent necessity in the program for the control of malaria in the state. An estimate was given as to the probable cost, items involved, etc. After some discussion the suggestion was favorably received and on March 4, the following resolution was adopted by the State Board of Health, namely, "that the State Board of Health undertake in coöperation with the University of California, a survey of malaria and mosquitoes in California under the direction of Professor W. B. Herms, assisted by Mr. S. B. Freeborn, provided the funds of the Board will permit of the financing of the plan." It was estimated that the expense of the survey would approximate $2,150 for the first summer including cost of automobile, maintenance, hotel expenses, and general equipment, there being no charge made to the State Board for the services of either the writer or Mr. Freeborn.

Without discussing in detail the equipment used in carrying on the survey, it may be said that this consisted of many maps, including

[1] von Ezdorf, R. H., 1916. Endemic Index of Malaria in the United States. United States Public Health Service, Reprint No. 331 from Public Health Reports of March 31, 1916.

[2] von Ezdorf, R. H. Anopheline Surveys. United States Public Health Service, Reprint No. 272 from Public Health Reports of April 30, 1915.

topographic maps, collecting outfit, numerous pill boxes and vials for use as insect containers, microscope, stain, cameras, first aid outfit, etc. The automobile used in the survey was of five-passenger capacity, equipped with a good sized dunnage box. The personal effects of the party were carried in cases and bags.

Between April 13, the date on which the automobile was received, and May 10, the day on which the scheduled survey began, a number of trips were made in the San Francisco Bay region as far south as Palo Alto to study certain local mosquito conditions. On the morning of May 10, the party, consisting of the writer, Mr. Freeborn and a student driver, who also gave his services free to the state, left the campus of the University of California. The first few days of the survey were spent chiefly in the Vaca Valley working from Suisun to Winters, thence to Dixon, Davis and Woodland, where a second party consisting of a group of University of California students joined in the work of the survey. This group of students remained with us for the first six weeks of the trip and proved of considerable value in collecting and locating breeding places. From Woodland our work proceeded up the west side of the Sacramento to Orland thence to Hamilton and south to Princeton and Colusa. From Colusa we again went northerly as far as Redding, thence southerly to the east side of the Sacramento to Chico, thence to Marysville. In each instance the intervening territory was carefully studied, and several days were devoted to a study of the more important communities and their tributary settlements. From Marysville we again proceeded northward to Redding, thence to Dunsmuir, Yreka, Hornbrook over the Siskiyou Mountains to Ashland (Oregon) in order to trace the species to the extreme northern boundary of the state. From Ashland the trip was made to Klamath Falls and at once into California again through Modoc County, stopping at Alturas, thence to Susanville and to Reno (Nevada) via Doyle. Our next headquarters were at Loyalton, thence to Sierraville, Truckee and Placerville via Lake Tahoe. Our first trip closed June 23, when a few days were spent at Berkeley to replenish our equipment.

The second trip began June 27, going directly to Sacramento thence to Marysville, Oroville, Quincy, Downieville, Nevada City, Grass Valley, Auburn, Truckee, Placerville, Jackson, Sonora, Yosemite, Merced, returning to Berkeley July 23. During this trip our principal object was to ascertain conditions in the northern Sierra foothill region.

On July 26 the third trip was begun and consisted of a survey of Marin County, particularly the salt marsh problem of San Rafael and vicinity, thence to Petaluma, Sonoma, Santa Rosa, Sebastopol, Healdsburg, Cloverdale, Hopland, Lakeport, Upper Lake, Middletown,

Calistoga and the Napa Valley, thence again to Berkeley. The final trip of the season consisted of a further study of conditions from Benecia to Suisun and the Vaca Valley, thence to Napa and Santa Rosa, northward to Ukiah, Laytonville, Eureka, Crescent City, easterly to Redding via Weaverville, southerly to Williams, westerly to Ukiah via Bartlett's Springs and Lakeport. From Ukiah the homeward journey was made via Santa Rosa and Napa including a mosquito survey of Mare Island. The summer's work closed August 14. From May 10 to August 14 we had covered 6,446 miles or 7,036 miles from April 13, and 31 northern counties had been officially included in the survey. We had travelled from sea level, actually on the sandy beach of the Pacific Ocean near Crescent City, to an elevation of about 8,000 feet in the Sierra Nevada Mountains. We had encountered rain, hail, snow, storm, heat and cold, often subjected to dangers and hardships, but we had visited the home of the mosquito and had seen at first hand conditions good and bad as they actually exist.[1]

Object and Method of Survey

The object of the survey was threefold, first, *scientific*, in that an accurate knowledge of the specific occurrence and distribution of mosquitoes and malaria was desired; second, *economic* and *remedial*, in that accurate information relative to the breeding places of the Anopheline species was needed in order that definite and practical suggestions for control could be offered; and third, *educational*, in so far as literature was distributed, lectures were given, conferences were held and much personal work was done among the ranchers. The objectives of the survey defined from the very start the methods pursued in our survey. The itinerary of each trip was prepared in advance and adhered to very closely. Adult mosquitoes were easily located in their hiding places during the day, commonly under bridges, in culverts and in outhouses. By the use of cyanide bottles made of shell vials (1″ to 1½″ deep and ¾″ in diameter) representative collections were made. After collecting them they were at once placed between cotton wadding in small pill boxes, each box given a number which corresponded to a number on a map. Breeding places were then located, descriptions were made and photographs taken in many instances. Ordinarily this peculiar performance attracted attention and soon one or more individuals were being told the object of our work. Health officers and other public officials were frequently taken into the field and given lessons in the recognition of mosquito larvæ, particularly the Anophelines, and were given suggestions for control. In nearly all communities resi-

[1]Herms, W. B. Progress Report on State-wide Mosquito Survey. Calif. State Board of Health Monthly Bulletin, vol. 12, No. 4, pp. 192–196. (Oct., 1916).

dent physicians were consulted relative to the occurrence of malaria in the vicinity and blood smears were examined wherever available. Public lectures, previously scheduled, were frequently given, usually illustrated with local material. Perhaps the most noteworthy lecture given during the summer was that at Redding before the state convention of County Supervisors. This was well attended and evidently well received. Hundreds of copies of the State Board of Health Special Bulletin No. 9 on "Malaria and Mosquito Control" by the writer were distributed. In most of the seriously infested localities a house-to-house distribution was made.

Results of Survey with Comments

We now have without doubt a very complete collection of the species of mosquitoes occurring in northern California and by the time the survey is finished a unique representative collection of these insects will be at hand such as few if any of the larger states possess. The specimens are being properly mounted and a card index of localities is being prepared so that information relative to the occurrence of mosquitoes in a given locality can be quickly and accurately ascertained. Our knowledge of the geographical distribution of the Anophelines has been greatly amplified. One or more of the specimens of Anopheles was encountered in all but one northern California county, and we were able to find numerous specimens of Anophelines, also located their breeding places, at an elevation of 5,482 feet (this at Sierraville).

We are even more impressed than ever that the Anopheles mosquito as a real menace to health does not wander far from its larval habitat, and that with the discovery of Anophelines their breeding place may be located within a very few rods of this point.

The chief source of Anophelines was quite commonly the green scum-covered edges of a small receding stream, creek or irrigation ditch, or grassy weed-grown pool of clear water. While the Anopheles mosquito may breed in vile stagnant water, it prefers clear, fairly cool water such as one frequently finds in smaller streams with sandy or pebbly bed. The current may be fairly swift in one part of the stream but the edges are commonly shallow and left-over scum-covered pools occur nearby.

While the survey has revealed the fact that Anopheline mosquitoes are more widely distributed than was at first believed to be the case and that consequently the malaria menace is also greater, we are no less positive in our belief that malaria can be brought under control. It is, however, a matter of detail, intensive rather than extensive. For example, a small overlooked pool of water, originating from a tiny stream beneath a fruit-packing house, may produce ample Ano-

pheles mosquitoes to distribute malaria among the employees who may work toward evening during the rush season, or larvæ may occur in an open spring which supplies drinking water for the nearby fruit-picking camp, etc. The successful operation of malaria campaigns calls for specially trained men.

Far too little attention is paid to the irrigation ditches and methods of irrigation in northern California. Until this matter receives proper attention there will always be more or less malaria in our irrigated districts. This is further evidence that details are overlooked and that the irrigation and drainage engineer to whom such matters as mosquito control are often referred is not meeting the requirements, that he is interested in the successful operation of the work at hand and is not responsible for the water as it may prove a menace to health. This is not ordinarily within the scope of his work. That there is little or no malaria in the irrigated districts of southern California is a mere coincident in the problem of conducting water from place to place in the most economical manner.

The recent introduction of rice culture in California brings with it new problems. These were studied with some care during the progress of the survey. Rice culture is evidently most successful in regions which also favor mosquitoes. In most instances both mosquitoes and malaria have preceded rice culture in a given locality, and the introduction of rice has merely increased the number of mosquitoes and the cases of malaria. In certain sections there is strong antipathy toward the rice industry because of its effect on health and comfort, on the other hand the rice grower displays a feeling of indignation because the entire responsibility is placed on his shoulders, in spite of the fact that both mosquitoes and malaria preceded the advent of his industry.

Out of our study of the rice situation there have come several important conclusions, namely that the rice grower is guilty of carelessness and does not practice sound agricultural methods. He is intent on quick returns at a minimum expense. The irrigation systems are as a rule carelessly constructed with the result that the roadsides are bordered for miles and in some instances actually covered by water. It is this careless and profligate use of water which is responsible for the enormous increase of mosquitoes. It seems quite reasonable to believe that more than 50 per cent of the trouble will be eliminated concomitant with the practice of scientific methods in the culture of rice.

Furthermore, after the water is drained from the fields in the autumn great numbers of pools remain along the contour checks and the roadsides in which mosquitoes continue to breed for some time after the

rice harvest, and again in the spring before the fields are flooded. Therefore it is recommended that mosquito control measures be put forth with vigor both before and after the fields are flooded.

While dragonflies breed in enormous numbers in the rice field they appear too late in the larval form to reduce the mosquito larvæ and the consequent hordes of mosquitoes to any appreciable extent. If dragonfly larvæ could be produced in sufficiently large numbers very early in spring and were transplanted to the rice fields at the beginning of the season some appreciable effect might be secured.

Bat roosts in the neighborhood of rice fields have been recommended but our experience with bats does not lend a very hopeful aspect to this means of control.

That much quinine is consumed in the malarial regions of California without apparent good results is quite evident. Self-treatment with large quantities of quinine without regard to schedule is commonly practiced. Enormous sums of money are expended for quinine and sundry patent medicines,—much of it uselessly.

The winter treatment of malaria carriers in all sections where the disease occurs and proper quinine prophylaxis in districts difficult to control deserve much more attention than is at present accorded these matters.

As a direct result of the malaria-mosquito survey there will come many new organized mosquito abatement districts under the act above described, but no doubt the greatest good coming out of the work is fundamentally educational in that literally thousands of persons,—men, women and children,—were reached on their own ground and were told what malaria is, how it is carried and how to control it. In many instances the writer saw the remedy (mosquito control) applied before he left.

It is planned to complete the survey of the state during the coming summer, starting early in May at the southern border and working northward.

The two papers were generally discussed by R. W. Doane, A. W. Morrill, Earl Morris, C. W. Woodworth, E. O. Essig and others.

CHAIRMAN A. W. MORRILL: The next subject will be presented by Mr. G. A. Coleman.

THE DEVELOPMENT OF THE MOTION PICTURE AND ITS PLACE IN EDUCATIONAL WORK

By Geo. A. Coleman, *University of California, Berkeley*

The story of the development of the motion picture camera and motion picture projectors reads like a fairy tale of romance, yet it is the story of real scientific achievement unequaled in its account of the overcoming of apparently insurmountable difficulties. For the solution of the scientific problems involved it has demanded the best talent from among European and American mechanical experts, designers and manufacturers of lenses, camera equipment, and chemists. The successful solution of these problems has only been possible through the coöperation of all.

Motion picture photography was born on the Stanford Ranch, Palo Alto, California, about 1872, when Governor Stanford was induced by Mr. Muybridge to allow him to experiment in photographing the governor's horses. The first motion pictures were made by setting up twenty-four cameras in a row facing the racetrack, each camera being equipped with an ingenious arrangement of a string and spring attached to the shutter. The horse in trotting past the cameras touched each string and so released the shutter, thus taking his own photographs, a series of snap shots. Governor Stanford rendered a real service to the science of Cinematography when he took these photographs to Paris and exhibited them, thereby gaining the attention and interest of Messioner, the great animal painter. Messioner was fascinated by them, because he was himself a great student of the curious attitudes which horses assume when in rapid motion, and had already attempted to incorporate in his paintings some of his own observations. These photographs gave him just the proof he needed to establish the correctness of his own observations with his fellow artists who were disposed to criticize his ideas and work. Indeed here we have the keynote to the use of the motion picture in scientific investigation and instruction, viz., an infallible record.

The motion picture camera has now been brought to a high state of mechanical perfection and optical efficiency. There are a number of good makes on the market. After a somewhat extended investigation of a number of foreign makes, the author has chosen the Universal camera and tripod, made in Chicago, which, equipped with a battery of lenses of from two to six inch focus, or longer if desired, makes an outfit adapted to all kinds of work afield, and will withstand the trying effects of all kinds of climate from the tropical jungle to the rigors of the arctic. (The outfit was here exhibited.)

The manufacture of motion picture films has kept pace with that of equipment, and owing to the indefatigable efforts of Mr. Eastman, we have film which will record anything the camera can take. To such perfection has the film, and the mechanical work of the camera been brought, that the taking of five hundred consecutive pictures in one tenth of a second, a thing undreamed of a few years ago, is now possible.

Here, then, we have the means of recording and reproducing for classroom and lecture room, and for careful study, all of the muscular and other movements of the vast animal and plant population of the entire globe. By means of the X-ray and the microscope, in connection with the motion picture camera, we can photograph not only the external, but the internal anatomy of every living thing upon the earth, in the air, or in the sea. When we stop to think of the vast field of investigation, of which we are just now at the threshold, we may stand in awe of the forces of nature, yet we cannot help but feel a profound respect for the powers of the human mind which has opened the door and let the general public get a glimpse of the innermost secrets which are so jealously guarded by old dame nature.

The "dry-as-dust" lecture on insect taxonomy can be enlivened now and then with a few feet of film, analyzing the "buzz" of the bee's wing, the "song of the katydid, or katydidn't," the "chir-r-p" of the cricket, the stride of "sir" beetle, and the sailing, or soaring, of "Madam Butterfly."

The insect biologist no longer needs to cover the walls with charts showing "all stages in life-history," etc., etc., or with curves, the key to which has long since been lost, for by means of the motion picture record he can get together a life-history stretching over months, or years, and present on the screen in a few minutes, the entire transformations for the eyes of the students, thus stimulating their interest to a study of the real insect life-history much more effectively than is possible with any series of dried or pickled specimens, however carefully they may be prepared.

Museum specimens have their uses, *as records*, but they also have *their limitations*, for classroom, or lecture demonstrations, besides, *it spoils the specimen*. Lantern slides were a step in advance, but too slow. The moment you introduce *motion* into your subject, your audience is fascinated, their attention riveted, and your point of instruction is driven home.

The economic entomologist need no longer fear the bugbear of classroom work, for he can now devote himself entirely to the research so dear to his heart, while an assistant merrily turns the crank of the Kinetiscope, or Pathescope, grinding out the pictures at the rate of

sixteen thousand every twenty minutes, stopping between reels to answer the stream of questions which the admiring multitudes of freshmen will certainly be stirred to ask. As for the general public,—a motor-driven machine, a few hundred thousand feet of film, covering all lines of scientific investigation, farm and orchard management, and you can take that long cherished—but seldom realised hope—a real vacation.

The following paper was read by title:

SOME COMPARISONS OF COCCUS CITRICOLA AND C. HESPERIDUM[1]

By H. J. QUAYLE, *University of California, Citrus Experiment Station, Riverside, California*

Coccus citricola was described as a new species in 1914.[2] For some years previous to that time, this species of scale insect was confused with *C. hesperidum* as well as with one or two other species. The identity of the two species named is still a matter of doubt with persons not familiar with them, and, in certain stages or without ample material, their identity may not be plainly evident even to those who have given the species some study. Nevertheless the species in question are quite distinct, and it is the purpose of this paper to point out some of the differences and also some of the similarities.

The most important morphological characters separating these two species of scale insects are to be found in the antennæ, both as regards the number and the relative lengths of the joints.

Hesperidum almost invariably has seven joints, while *citricola*, in the great majority of cases, has eight joints.

In seventy-eight specimens of *citricola* in which 139 antennæ were examined, there were three scales each with seven joints in one antenna and eight in the other. In four scales there were seven joints in both antennæ, and in four others there were seven joints in one antenna while the other antenna was not examined. The remaining number, or sixty-seven, had eight joints in both antennæ.

In seventy-three specimens of *hesperidum* examined all had seven joints.

---

[1]Paper No. 42, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

[2]Campbell, Roy E. A new species of Coccid infesting citrus trees in California. Entomological News 25: 222–224, 1914.

In all scales examined the seventh, or usually the next to the last, joint of *citricola* was shorter than the seventh, or last, joint of *hesperidum*.

With two exceptions the fourth joint of *citricola* was shorter than the fourth joint of *hesperidum*.

Considering averages, in the majority of antennæ examined the third joint of *citricola* was shorter than the third joint of *hesperidum*.

Considering averages, the fifth joint of *citricola* was longer than the fifth joint of *hesperidum*.

Although *citricola*, usually, has one more joint than *hesperidum*, the total length of the antennæ of *hesperidum* will average longer than that of *citricola*.

C. CITRICOLA

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.0	9.05	11.88	9.80	9.73	7.56	7.43	13.14	78.59

C. HESPERIDUM

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.2	9.94	15.92	16.82	6.60	7.18	16.43	—	83.09

In *hesperidum* the number of hairs of the anal ring is usually given as eight. In the original description of *citricola* six was the number stated for this species. Upon examination of the above characters, the writer finds that there are six large and two small hairs on the anal ring of both *hesperidum* and *citricola*. The two small hairs are not readily seen without dissecting out the part and mounting so as to show all the hairs in about the same plane. While, from the observations of the writer, the number of hairs of the anal ring is the same in both species in question, the difference in their length is very marked, those of *hesperidum* being about one-fourth longer than those of *citricola*.

There appears to be no well marked distinctions between the motile larvæ of the two species. The antennæ in this stage consist of six joints. In *citricola* there is an indication of eight joints by a more or less distinct separation of the fourth and fifth into two joints each. In the second instar there are still but six joints although the cleavage into two of the fourth and fifth joints is more pronounced than in the larva. In the third instar the adult condition of eight joints is acquired. In the case of *hesperidum*, the extra joint of the adult is probably formed by the fifth joint dividing into two.

In general appearance *citricola* may be distinguished by the more even distribution of the dark color pigment and the general ground

color of gray or dirty white. *Hesperidum* has the color pigment coalesced in more or less definite areas and the ground color is distinctly yellowish. In lustre, *citricola* is dull while *hesperidum* is shiny.

Hesperidum varies in shape more than *citricola*. The former may be straight on one side and curved on the other, or otherwise different from the usual oval, particularly, if they are situated along the midrib or if the specimens are crowded closely together.

It is in their life history and habits that the two species are markedly different. In *citricola* there is but one generation a year, while in *hesperidum* there are three or four over-lapping generations. Individuals of different sizes that may be seen at any one time in the case of *hesperidum* furnish a ready means of distinguishing the two species. From August to March all living specimens of *citricola* are uniformly of small size. During May, June and July there may be two sizes of this species, either mature individuals or very small specimens. *Citricola* is oviparous while *hesperidum* is ovoviviparous. The male of *citricola* is only occasionally seen. On citrus trees the puparium of the male of the black scale (*Saissetia oleæ*) is likely to be mistaken for that of *citricola*. The puparium of *citricola* may be distinguished from that of the black scale by the broader band, consisting of numerous cross lines, bordering the coronet. There are several references that refer to the male of *hesperidum*, but in the writer's judgment the proof in these references is not sufficient to say positively that the male described was of this species. Male puparia have been taken in the midst of infestations of *hesperidum*, but in all cases observed, they proved to be that of *S. oleæ*, *L. corni* or *C. citricola*, infestations of which were in the immediate vicinity. It is not unlikely that the male of *hesperidum* occurs, but evidence of the fact in the references at hand seems insufficient.

The host plants of *hesperidum* include a very wide range in number and variety. Those of *citricola*, as far as observed, include all varieties of citrus, hackberry, *Celtis occidentalis;* buckthorn, *Rhamnus crocea;* pomegranate, *Punica granatum;* night shade, *Solanum douglassi;* English walnut, *Juglans regia;* and Elm, *Ulmus americana*. The host plants named, other than citrus, were found infested in more or less close proximity to citrus. The discovery of the scale on hackberry, some of which trees were said to have been imported from Japan, led to the suspicion that the scale may have come from that country. But in correspondence with entomologists in Japan it is learned that *C. citricola* is not known to occur there, or at least is not native to the country. Mr. C. P. Clausen writes that he has seen what he considers to be *C. citricola* on citrus in Japan, and that it probably has been introduced from California.

C. citricola was first observed on buckthorn growing in the immediate vicinity of a citrus nursery. Since the buckthorn is a native plant, growing in the mountains and in waste places in the valleys, it was thought that the origin of the scale was accounted for. Upon further exploration of different areas where buckthorn grows, it was found that infestations of the scale on this plant did not occur at any great distance from infested citrus trees. The scale was found most abundantly on buckthorn growing in immediate proximity to citrus trees. It has been found in scattering numbers on the same plant growing in the washes from Claremont to Glendora. Specimens have been taken on buckthorn in the San Dimas and San Gabriel canyons two miles from citrus trees. It was not observed on buckthorn in the vicinity of Santa Barbara or in Laurel Canyon near Hollywood, or elsewhere. Further exploration of the buckthorn may result in a different conclusion, but at present it appears that *citricola* went from the citrus to the buckthorn instead of *vice versa*.

The parasites that have been reared from both *citricola* and *hesperidum* include *Coccophagus lecanii*, *C. lunulatus*, and *Aphycus luteolus*. *Microterys flavus* is a common parasite of *hesperidum* but thus far, there appears to be no record of this species being reared from *citricola*. *Coccophagus flavoscutellum* has been reared from *citricola* but not from *hesperidum*. Timberlake[1] records some other parasites and hyperparasites of *hesperidum* which have not been reared from *citricola*, but less extensive studies have been made on the parasites of the latter species. It is well known, however, that *citricola* is much less subject to attack by parasites than *hesperidum*.

At the South Carolina College and Station, two laboratories in charge of Mr. G. M. Anderson have recently been established in the southern part of the state; one deals with the boll weevil problem, and the other with the American mole cricket which is developing into a serious pest, especially of truck crops, at some points along the coast. Mr. J. A. Berly, research assistant, is in charge of the temperature-moisture problem at the home laboratory, working in coöperation with the division of Southern Field Crop Insects of the Bureau of Entomology. Professor W. A. Thomas has about completed his work on the cotton root louse and at present is engaged in a special study of the Aphididæ of South Carolina, with special reference to economic control. The work of the Crop Pest Commission has developed satisfactorily during the past year. An item of particular interest is the absolutely successful control of three heavy infestations of the cottony cushion scale in Charleston by the introduction of the Vedalia lady beetle, through the courtesy of the Plant Commissioner of Florida.

---

[1]Timberlake, P. H. Preliminary report of the parasites of *Coccus hesperidum* in California, Jour. Econ. Ent. 6: 293–303, 1913; and Revision of the Genus *Aphycus*, Proc. N. S. N. M. 50: 561–640, 1916.

Scientific Notes

Aleyrodes citri not in Porto Rico. In the April number of *Phytopathology*, in an article on Porto Rican plant diseases, appears the following statement: "The fungus appears to be growing upon a scale insect, probably *Aleyrodes citri*." This statement refers to a white-fly found on the undersides of the leaves of Guava, the writer assuming that it is the notorious citrus white-fly.

Aleyrodes citri Riley and Howard has never been found in Porto Rico to our knowledge. There are, however, two species of white-fly that are commonly found on Guava in Porto Rico, *Aleurothrixus howardi* Quaintance and *Aleurodicus* (*Metaleurodicus*) *minimus* Quaintance, and it is very probably one of these to which the writer refers.

RICHARD T. COTTON.

How the Bureau of Entomology is Meeting the Great Issue. Immediately upon receipt of the news of the Declaration of War, the following letter was transmitted by the Chief of the Bureau to each member of the Bureau of Entomology, both in Washington and in the Field Service:

April 7, 1917.

"The crisis in which this country is placed makes it necessary for the Bureau to do all it can towards the conservation of our resources. It has been decided to establish a system of reporting local outbreaks of insects so that the Bureau will have the earliest possible information regarding unusual injury to crops. This service will receive reports on insect abundance, make tabulations and maps, and compile statements for the use of the men in the field as to probable damage.

"Will you please make it a part of your duty to report promptly through your section chief all observations on insect damage which are of more than usual intensity, and report the first occurrence of well-known pests. In all cases where possible numerical estimates should be made. This work should cover all injurious insects which may come to your attention regardless of the work in which you may be regularly engaged. It is not intended, however, that this shall supplant the regular work. It should be merely incidental but at the same time carried on to as full an extent as possible without interfering with other important matters.

L. O. HOWARD."

The Department of Entomology of the Alabama Experiment Station is endeavoring to do its bit in the campaign for increased food supplies partly through the saving of at least $2,000,000 worth of corn that is liable to be destroyed by insect attack in the cribs during the next two or three months. Furthermore, arrangements have been made for prompt reports by demonstration agents, agriculturists in our District Agricultural Schools and others of any threatening insect occurrence in this state. An effort will be made to get these reports much earlier than they would come ordinarily from the farmers themselves, so that remedial measures may be applied in time to prevent loss.

In the Gulf States section, the winter of 1916 and 1917 has been the most severe for perhaps 18 years past. Serious damage has been done by cold to citrus fruits and figs particularly, also in a less degree to other fruit crops. Probably as a partial result of winter injury, more numerous reports are being received of injury in which some new fungus diseases and borer injury seem to be associated. Some of these attacks are occurring upon a large variety of fruit and forest trees and promise to be serious problems for future study.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints, if ordered when the manuscript is forwarded or the proof returned, will be supplied authors at the following rates:

Number of pages	4	8	12	16	32
Price per hundred	$2.00	$4.25	$5.00	$5.50	$11.00
Additional hundreds	.30	.60	.90	.90	2.00

Covers suitably printed on first page only, 100 copies, $2.50, additional hundreds, $.75. Plates inserted, $.75 per hundred on small orders, less on larger ones. Folio reprints, the uncut folded pages (50 only), $1.00. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

It may be well to call attention to practical limitations evident to anyone giving the matter thought and yet apparently ignored by some. Recent volumes of the JOURNAL have contained about 600 pages and represent practically all that can be issued with present resources. There are approximately 450 members with equal opportunities for publication. It was decided some years ago, and the policy seems on the whole a wise one, that precedence should be given to the Proceedings. That decision was made before we had a Pacific Slope Branch with its summer meeting and it seemed only an extention of the earlier policy to apply it to the western gathering. The large number of papers presented at a meeting necessitated limiting the time devoted to each and some have given abstracts or portions and submitted the entire paper for publication. Considerable discretion must lie with the Editor and the above statement is made for the benefit of one who becomes impatient at delay or who looks askance at suggested condensation. Some authors have withdrawn papers because they could not be published earlier and under present conditions the Editor was powerless, so far as hastening matters is concerned. Here is a place where we must all coöperate. Adaptation will do more to help the situation than rigid regulation.

Edwards' Bibliographic Catalogue of the Described Transformations of North American Lepidoptera is favorably known to economic entomologists and, in earlier days at least, was exceedingly useful. The

great expansion of knowledge since the above-named work appeared has made aids of this character most desirable. There is a manuscript which brings this publication nearly to date; it has been completed for some time and there appears to be no immediate prospect of its being published. The usefulness of this compilation, though technical in nature and necessarily somewhat extended, is apparent to every practical entomologist and it is suggested that those appreciating such assistance should interest themselves in this matter. The work would, in an indirect manner at least, be extremely helpful to an extended clientage, since the efficiency of the entomologist is greatly increased if he can have at hand a volume which will quickly and surely put him in touch with all available information concerning the Lepidoptera—a group comprising many of our most important and destructive pests.

Current Notes

Conducted by the Associate Editor

Mr. C. H. Cale has been appointed to take charge of the apicultural work at the Maryland State College of Agriculture at College Park, Md.

Mr. George G. Schweis, formerly assistant entomologist in the Nevada Agricultural Experiment Station, has been appointed state apiary inspector for the state of Nevada.

The following resignations from the Bureau of Entomology are announced: George H. Rea, to accept an appointment at Harrisburg, Pa.; Mr. Neuls, Alhambra, Calif., to go into business.

The legislature of Minnesota has passed a law authorizing the state entomologist to control the pine blister rust and appropriating $15,000 for the next two years for this purpose.

Mr. W. R. Walton of the Bureau of Entomology has been placed in charge of Cereal and Forage Insect Investigations, the position formerly held by the late Professor F. M. Webster.

Professor C. L. Metcalf of Ohio State University is to return about June 10 for the summer, to the Maine Agricultural Experiment Station for a continuation of his Syrphid studies.

According to *Science*, the Rev. O. Pickard-Cambridge, F. R. S., author of works on arachnology, entomology, and general natural history, died on March 9, at the age of eighty-eight years.

Mr. W. J. Chamberlin, assistant in Forest Entomology at the Oregon Experiment Station, has been granted an indefinite leave of absence to enter the Officers' Reserve Corps training camp in California.

Mr. Marion Wadley, a graduate student of the Kansas State Agricultural College, has accepted a position in the Division of Truck Crop and Stored Product Insect Investigations of the Bureau of Entomology.

Professor W. C. O'Kane, Durham, N. H., and Harold L. Bailey, Bradford, Vt., were among the entomologists attending the hearing regarding the white pine blister rust, held before the Federal Horticultural Board at Washington, D. C., April 10.

Mr. William C. Woods will be a member of the summer staff at the Maine Agricultural Experiment Station for the summer of 1917. He will be engaged with "Emergency Entomology" and special work with Chrysomelid beetles.

Mr. August Busck of the Bureau of Entomology recently visited Mexico, in the region of Monterey, San Pedro and Torreon, where Egyptian cotton has been planted, to study the extent of the pink bollworm infestation.

Mr. H. M. Parshley of the Bussey Institution, Harvard University, has accepted an appointment as assistant professor of Zoölogy at Smith College, Northampton, Mass., and will begin his duties with the next college year in September.

Mr. H. J. Reinhard, assistant entomologist of the Texas Station, is completing extensive studies on the artificial control of the cowpea weevil, *Bruchus quadrimaculatus* Fabr. Special attention has been given to heat as a means of control.

Professor Franklin Sherman, Jr., was appointed to represent the American Entomological Society at the inauguration of Wallace Carl Riddick as president of the North Carolina College of Agriculture, Raleigh, N. C., on February 22, 1917.

Professor Charles T. Brues of Bussey Institution, Forest Hills, Mass., Mr. Harold L. Bailey of Bradford, Vt., and Mr. James A. Hyslop of the Bureau of Entomology, stationed at Hagerstown, Md., recently visited the Connecticut Station at New Haven.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, has also recently been appointed consulting zoölogist by the Canadian government, and will advise in matters relating to the protection of birds and mammals and the treatment of noxious species.

Mr. S. C. Clapp, assistant in Entomology, North Carolina State Department of Agriculture for nine years, has been appointed superintendent of the Mountain Station of the Experiment Station and State Department of Agriculture at Swannanoa, N. C., and entered on his new duties in February.

Very interesting but rather unexpected results are being obtained in the exhaustive artificial migration tests with the cotton or melon louse, *Aphis gossypii* Glov., by F. B. Paddock, state entomologist of Texas. There are two color forms of this species which complicates the migration tests.

At the annual meeting of the National Academy of Sciences convened April 16 and adjourned April 18, Mr. W. V. King, of the Bureau of Entomology, introduced by Dr. L. O. Howard, presented a paper entitled, "Sporogony of Malaria Parasites," with photomicrographs of infected *Anopheles*.

At the present time beekeeping is taught in the agricultural colleges in twenty-two states. In all but one or two cases this work has been inaugurated within the past five years. In ten of these colleges, the work occupies the exclusive attention of at least one instructor.

Mr. I. M. Hawley (Ph.D. Cornell) has been appointed assistant in the Division of Entomology, State Department of Agriculture, Raleigh, N. C., and began work in February. He succeeds Mr. S. C. Clapp. He will be responsible for much of the inspection work, and will also undertake some investigation projects.

Mr. C. H. Popenoe of the Bureau of Entomology has recently returned from a trip to Philadelphia for the purpose of inaugurating a fumigation of baled furs by the vacuum system. The John B. Stetson Company has recently installed a plant capable of a capacity of 50–1200 pound bales of fur per day.

Provision has been made to repeat the vacuum fumigation tests with pink bollworm larvæ under the direction of Mr. E. R. Sasscer of the Federal Horticultural Board to confirm results obtained in the earlier experiments, and also to determine the effect on these larvæ of the residual gas remaining in cotton bales. The living material for these tests was obtained from Hawaii through Mr. C. E. Pemberton.

Mr. E. J. Vosler, who for several years has been secretary of the California State Commission of Horticulture and editor of the *Monthly Bulletin*, has recently been appointed foreign collector of beneficial insects for the Commission. Mr. George P. Weldon succeeds him as editor of the *Bulletin*, and Mr. H. S. Maddox as secretary of the Commission.

The last General Assembly of Arkansas created a State Plant Board which will henceforth have charge of all orchard and nursery inspection work, and will have headquarters at Little Rock. Professor J. Lee Hewitt, plant pathologist of the Station, has recently been appointed chief inspector, and for the time being should be addressed at Fayetteville, Ark.

The following transfers have been made in the Bureau of Entomology: E. J. Newcomer from Wenatchee, Wash., to Portland, Ore.; Alan G. Webb, Boston, Mass., to Seattle, Wash.; G. D. Smith, Thomasville, Ga., to Madison, Fla.; A. J. Ackerman, West Chester, Pa., to Benton Harbor, Mich.; Frank R. Cole, Washington, D. C., to Hood River, Ore.; C. E. Smith, Baton Rouge, La., to Muscatine, Iowa.

Dr. R. R. Parker, assistant entomologist of the Montana State Board of Entomology, will continue the study of the Rocky Mountain spotted fever tick this season and will be located in a field station at Musselshell, Montana. He will be assisted by Mr. R. W. Wells, who received the degree of Master of Science in Entomology from Montana State College this year.

Dr. G. F. White of the Bureau of Entomology, who has done much work on the bacteria of apiary diseases, has now been assigned to diseases of insects, Cereal and Forage Insect Investigations. He will give particular attention to bacterial diseases, such as wilts of larvæ, etc., and will be glad to receive specimens supposed to be attacked by bacterial or other diseases.

Mr. George H. Rea, who has been recently employed with the U. S. Bureau of Entomology, has been appointed Chief Apiary Adviser under the Pennsylvania Bureau of Economic Zoölogy, and will take immediate charge of the field work in this line. Approximately fifty demonstration meetings have been arranged for the month of May in various bee yards in thirty-three counties of the state.

Mr. C. H. Popenoe, entomological assistant, and Mr. N. F. Howard, expert on Insects as Carriers of Plant Diseases, both of the Bureau of Entomology, attended the meeting of entomologists and plant pathologists at Pittsburgh, Pa., April 16–17, to discuss plans for coöperation with the H. J. Heinz Company and state officials on the project of insects as carriers of cucurbit wilt and other diseases of truck crops.

The chief project taken up by Professor A. L. Lovett, entomologist at the Oregon Experiment Station, consists of a study of the toxic sprays for insects. The work this year will include an intensive study of spreaders for arsenate of lead, the use of calcium arsenate alone and in combination under Western Oregon conditions, and

the use of nicotine sprays and oil sprays as repellents for insects which disseminate fire blight.

Mr. W. H. Goodwin, who has been at the Ohio Experiment Station for nine and one-half years, entered upon his duties May 1 at the Pennsylvania Department of Agriculture, Bureau of Economic Zoölogy, and will be in immediate charge of the sixteen men in the field, known as "crop pest advisers." Especial emphasis is being placed this year on potato growing, with particular attention directed toward the control of pests ordinarily affecting this crop.

Dr. J. F. Illingworth, professor of Entomology, College of Hawaii, Honolulu, has been granted a leave of absence for three years, in order that he may carry on investigations for the Queensland government. He is to be located at Gordonvale, Cairns, North Queensland, in the midst of the sugar-growing section. An experiment station is to be developed, primarily for the study of the grub-pest, which is such a scourge in certain cane-growing areas.

The Connecticut legislature has recently passed a new crop pest law applying to future emergencies, and giving the director of the Agricultural Experiment Station authority to take such measures as may seem necessary for the extermination or control of all pests. A separate measure has also passed, appropriating $15,000 for the next two years for the control of the white pine blister rust; of this, $5,000 is at once available, and work has already been started.

The Iowa legislature has recently passed a law which reorganizes the apiary inspection work of the state and unites it with the extension work in beekeeping of the State College of Agriculture and Mechanic Arts at Ames, according to the recommendations of the present inspector, Mr. Frank C. Pellett. This change becomes operative July 1. It is understood that Mr. Pellett will relinquish the work on his own motion, but no announcement has been made regarding his successor.

Mr. H. L. Seamans, assistant state entomologist of Montana, will be occupied with crop defense work throughout Montana this season. In addition to answering emergency calls to suppress outbreaks of insect pests, he will tour the state and conduct a survey of important pests. For the most part travelling in the various counties will be done by automobile in company with the county agricultural agents. Several outbreaks of army cutworms have occurred already and young grasshoppers are abundant in some localities in western Montana.

Mr. J. L. King, who has been at the Ohio Experiment Station for five years, assumed new duties in the Pennsylvania Bureau of Economic Zoölogy beginning May 1, and he will devote his entire time and attention to a thorough biological study of the Angumois grain moth, which, in the five southeastern counties of Pennsylvania most seriously infested, caused damage to the extent of more than a million dollars in 1916. The biology of this pest has not been thoroughly determined in this country, and the problem looks very interesting.

Mr. J. L. Webb, of the U. S. Department of Agriculture, Bureau of Entomology, has resumed work at Topaz, Calif., upon the Tabanids, *Tabanus punctifer* and *Tabanus phænops*. This project is undertaken in coöperation with the Nevada Agricultural Experiment Station. Studies will be made in Nevada and in adjacent portions of California. These studies will include general data on the injuriousness of the flies, their effect on growth and milk production, the relation between the abundance of the flies and irrigation and drainage, together with biological data and studies upon methods of control.

Mr. Hubert Jarvis, assistant entomologist of Queensland, made a flying trip to Hawaii during February. In spite of the brief time that Mr. Jarvis spent in the Islands he was very successful in his mission, which was the securing of a considerable stock of the lantana Agromyzid flies for his government. The signal success of these flies in Hawaii, in preventing the seeding of this most troublesome weed, had led other countries to seek similar relief. This Agromyzid, which apparently is an unnamed species, was introduced into the Hawaiian Islands by Mr. Albert Koebele many years ago.

The following entomologists recently visited the Bureau of Entomology at Washington: Dr. G. C. Crampton, assistant professor of Entomology, Massachusetts Agricultural College, Amherst, Mass.; Prof. J. Chester Bradley, systematic entomologist, Cornell University, Ithaca, N. Y.; Mr. R. C. Shannon, Cornell University, Ithaca, N. Y.; Prof. James G. Sanders, economic zoölogist, Harrisburg, Pa.; Prof. W. L. Chandler, instructor in Entomology and Parasitologist of Cornell University, Ithaca, N. Y.; Mr. J. R. de la Torre Bueno, hemipterist, New York, N. Y.; Prof. A. B. Cordley, director of the Experiment Station, Corvallis, Ore.; Dr. T. J. Headlee, state entomologist, New Brunswick, N. J.; Mr. J. R. Malloch, University of Illinois; and Mr. W. C. O'Kane, state entomologist, Durham, N. H.

In 1906, when Bureau of Entomology Bulletin No. 61 was issued, there were laws in twelve states providing for the inspection of apiaries. Most of these laws have been since replaced by more effective ones. At present there are such laws in twenty-nine states, and in addition, Hawaii and Porto Rico have regulations to prevent the introduction of bee diseases. In all there are about one hundred apiary inspectors in the United States. Thirty-four states now have state associations of beekeepers and five have associations for marketing honey. In addition to these there are now many county associations.

The following recent appointments are announced in the Bureau of Entomology: James A. Dew, Federal Horticultural Board, to be stationed at Eagle Pass, Tex.; Merton C. Lane, to be stationed at Forest Grove, Ore.; Herman J. Hart, assigned to the field station Wellington, Kan.; Dean A. Ricker, field laboratory, West Lafayette, Ind.; F. M. Wadley, Wichita, Kan.; H. K. Laramore, Plymouth, Ind.; Arthur J. King, Vashon, Wash.; O. A. Pratt, Calexico, Calif., transferred from the Bureau of Plant Industry. As collaborators in subtropical countries: Adolph Hempel, state entomologist of Sao Paulo, Brasil; Dr. Carlos E. Porter, director Institute Agricola de Chile, Santiago, Chile; F. W. Urich, government entomologist, Port of Spain, Trinidad; Archibald H. Ritchie, government entomologist, Jamaica; Patricio G. Cardin, government entomologist of Cuba, Santiago de las Vegas, Cuba.

The Connecticut mosquito drainage law has recently been amended by the General Assembly providing for a more comprehensive notice to property owners; for appeal and a method of assessing benefits and fixing damages; for state control of maintenance; that the law apply to work done before the passage of the present act if approved by the Director of the Agricultural Experiment Station; for the appointment of deputies; for one-fourth the cost of both maintenance and new work to be borne by the state, and the remaining three-fourths by the town, city or locality. The bill carries an appropriation of $10,000 to cover the state's portion, one-half for new work and the other half for maintenance.

The recent appropriations made by Congress for the Bureau of Entomology aggregate $931,480, being an increase of $62,600. For the control of the gipsy and brown-tail moths $305,050 is provided, and $25,000 is named for investigations relating to the cotton boll weevil, and lesser amounts are to be expended for special studies of

the Hessian fly, chestnut weevils, insects affecting pecans and other nuts, for the control of insect carriers of plant diseases in coöperation with the Bureau of Plant Industry, and for enlarging the work on insecticides. It is also contemplated that a field laboratory be established in the Ozark Mountain region in Arkansas and a field station in one of the New England States for investigations of the apple-tree tent caterpillar.

The Arizona legislature has appropriated $42,000 for the biennium beginning July, 1917, for the work of the state entomologist. Entomological work was organized in Arizona in 1909 with an appropriation of $3,000 supplemented by $600 from the Agricultural Experiment Station. Since then the successive legislatures have increased the appropriations from $3,000 a year to $5,000, $12,000, $14,000 and $21,000. The menace to the alfalfa crop by the introduction of the European alfalfa weevil into the adjoining state of Utah and the rapid development of the Egyptian cotton industry are factors largely responsible for the increasing interest shown in entomological work in the state of Arizona. After July 1, 1917, it is planned to add an assistant plant pathologist and a second assistant entomologist to the scientific staff.

Mr. Warren Knaus (class of 1882, Kansas State Agricultural College) has donated to the Entomological Museum of the Kansas State Agricultural College his valuable collection of Coleoptera. Ever since he was a student in the College, Mr. Knaus has spent practically all of his spare time and vacations in collecting and studying the Coleoptera. He has made many trips into the arid regions of Mexico, Arizona, Texas, and New Mexico to collect insects. These trips have been productive of a great many new species. His collection contains a number of species that are only found in one or two museums in the world, and these were furnished by Mr. Knaus. His collection will be kept as a separate one and will be known as the "Warren Knaus Collection."

An Insect Pest Survey and Information Service, has been undertaken by the State Entomologist of New York in coöperation with the New York State Food Supply Commission, the State College of Agriculture, the Farm Bureaus, the State Experiment Station and other agricultural agencies. It is also coöperating with the Emergency Entomological Service of the Federal Bureau of Entomology.

The main purpose is to secure prompt and accurate reports from all sections of the state, to summarize the information thus obtained, distribute it promptly and thus promote the checking or prevention in large measure of the enormous losses inflicted by insect pests. Particular emphasis is laid upon the initial signs of injury in order that damage may be anticipated and the insects controlled. The project is closely articulated with the control work in the field under the supervision of Messrs. Crosby and Matheson of Cornell University, and plans now maturing may result in what is practically an entomological patrol. The more important crops receive first attention, especially the insect enemies of potatoes, cereal and forage crops, truck and garden crops and the important fruits.

There are approximately one hundred observers reporting weekly and digests of the information with special recommendations in regard to the various pests are placed in the hands of the county representatives of the New York State Food Supply Commission and other interested parties with the expectation that every reasonable effort will be made to secure the general adoption of well-known and effective preventive or remedial measures.

Mailed June 19, 1917